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April 06, 2006

Ms. Gwen B. Zervas, P.E.
Section Chief
Bureau of Case Management
New Jersey Department of Environmental Protection
401 East State Street
Trenton, NJ 08625

Subject: Ventron/Velsicol Superfund Site
Wood-Ridge, Bergen County, New Jersey

Dear Ms. Zervas:

Morton International, Inc., a subsidiary of Rohm and Haas Company, is pleased to submit the enclosed revised Feasibility Study (FS) Report, Operable Unit 1 for the Ventron/Velsicol Superfund Site, Wood-Ridge/Carlstadt, New Jersey. This FS Report addresses NJDEP/USEPA comments received on March 10, 2006, and NJDEP comments received by Rohm and Haas via e-mail on January 27, 2006, on the FS Report dated January 5, 2006. A summary of agency comments and responses that are developed in greater detail in the report follows.

Combined Agency Review Comments (March 10, 2006)

1. ***Because it is still uncertain whether the owners of adjacent properties (e.g., Blum, Prince, Packing, and Lin-Mor properties) will actually agree to deed restrictions, the FS should provide alternatives and cost information for complete removal (to below New Jersey RDCSCC levels) as well as capping with deed restrictions.***

   The Soil Media Alternatives have been reordered (see response No. 26a) and modified such that the adjacent properties (EJB, Blum, and Prince Packing) are excavated to RDCSCC levels beginning with Soil Media Alternative 5. Text has been added in Section 4 (***Land Use Restrictions*** subsection) to Soil Media Alternatives S-3 and S-4 that states *"If a notice of intent for a deed notice(s) for an adjacent property(ies) is not obtained prior to remedial construction, that property(ies) will be excavated to the RDCSCC for the Site's COCs."* The Lin-Mor property is proposed for excavation to RDCSCC levels beginning with Soil Media Alternative 2. A new table that summarizes property-specific remedial activities (including excavation to either the 620 mg/kg mercury target level or excavation to RDCSCC levels for the Site's COCs) has been added to the FS as Table 5-2. Estimated costs for the excavation, handling, transportation, and placement/compaction of this excavated material under the Undeveloped Fill Area cap or for off-site disposal have been itemized in the Detailed Cost Tables contained in Appendix C.

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2. *Alternative Screening - Response to comment 5, Section 3, as well as Table 3-1. Retorting and soil washing are screened out, but then it is stated that retorting and soil washing may be used if solidification/stabilization does not work out. Technologies that may be used if a preferred technology is not implementable should not be screened out, but instead the evaluation process describes why the preferred alternative is better. In other words, include all three, and point out that solidification/stabilization would most likely be the treatment technology employed, unless it is determined that solidification/stabilization is not appropriate for the specific characteristics of soil from the site.*

   Based on the physical and chemical properties of the Site's mercury-contaminated soil, solidification/ stabilization of mercury-contaminated soil from the Site appears to be the most technically feasible and implementable treatment technology available. This assumption will be validated during a pre-design treatability evaluation. To maintain maximum flexibility in treatment technologies available for the pre-design phase should solidification/ stabilization prove to be ineffective, soil washing and retorting technologies are now carried forward in the screening process within Section 3 and, specifically, in Table 3-1. The *Ex Situ Treatment Category* subsection in Section 3.3 has been modified to describe why solidification/ stabilization is the primary ex situ treatment technology retained, whereas soil washing and retorting technologies are retained as secondary ex situ treatment options.

3. *Please add the following Remedial Action Objective for soil: Prevent/minimize potential migration of contaminants to ground water, which may discharge to surface water and sediment.*

   The recommended RAO for soil has been added as the second bullet in subsection 2.2.1, along with a description of the RAO. The RAO bullet has also been added to subsections 4.1 and 5.3.2.1. Existing text in the *Detailed Analysis of Soil Media Alternatives Section* (Section 5.3) includes a discussion of how the various alternatives minimize the potential migration of COCs from impacted soil to groundwater (Subsection 5.3.2.1).

4. *Section 1.5.1, Page 1-10: This section is supposed to discuss the nature and extent of contamination but instead focuses on comparing onsite concentrations to concentrations typical of historic fill. Of particular concern is the absence of any mention of the "hotspots" for lead in the undeveloped area and mercury in both the undeveloped and the developed areas. It is recommended that the following revised text be included:*

- *Section 1.5, Page 1-9:*

  "The highest concentrations of mercury seen in soil, which have been identified as hot spots due to their anomalously high concentrations, are located beneath the former mercury...."

- *Section 1.5.1, Page 1-12, Lead bullet:*

  "...would be seen with depth. In addition, an anomalously high concentration of lead, identified as a hot spot, was detected in the undeveloped portion of the site."

Based on e-mail correspondence with the NJDEP and USEPA on March 28, 2006, and April 5, 2006, respectively, the following revised language has been added to the referenced sections of text:

- Section 1.5, page 1-9 - "*The highest concentrations of mercury seen in soil are located beneath the former mercury...*"
- Section 1.5.1, Page 12, lead - "*In addition, the highest level of lead was detected in the undeveloped portion of the site.*"

5. ***Section 2.1.1.1, Page 2-2: The last sentence in the first paragraph of this section is confusing. Region 9 MCLs are listed in the paragraph that discusses soil criteria. If the text is referring to Region 9 PRGs, please note that these values are TBCs, and not ARARs. If the text is referring to MCLs, please move this sentence to the next paragraph, which identifies the groundwater ARARs and TBCs.***

   The text was referring to Region 9 PRGs. The acronym 'MCL' has been revised to 'PRG' and 'ARAR' to 'TBC' in the referenced sentence.

6. ***Section 2.4.1, Page 2-8: The first paragraph discusses surface soil mercury concentrations exceeding PRGs. The hazardous substance sample collected from the undeveloped portion that yielded a result of 295,000 mg/kg (HS-5) is not referenced. Although this is not a soil sample, it is included in the HHRA as a result from the remedial investigation sampling and should be included in this section.***

   The following text has been added to the first paragraph of subsection 2.4.1:

   "In addition, one hazardous substance (HS) sample collected from the undeveloped fill area (HS-5) yielded a mercury concentration of 295,000 mg/kg. This sample was characterized as white-yellow powdery material and melted thermometers."

This material, in addition to the material associated with HS-6 discussed in comment No. 7 below, if found during the remedial action, will be managed appropriately.

7. *Section 2.4.1, Page 2-9: The last paragraph of this section presents the lead results in soils. This section should also include mention of HS-6, at which lead was detected at a concentration of 47,600 mg/kg. Although this is not a soil sample, it is included in the HHRA as a result from the remedial investigation sampling and should be included in this section.*

   The following text has been added to the last paragraph of subsection 2.4.1:

   "In addition, one HS sample collected from the undeveloped fill area (HS-6) yielded a lead concentration of 47,600 mg/kg. This sample was characterized as a hard, red pigment."

   This material, if found during the remedial action, will be managed appropriately.

8. *Section 3.3, Page 3-8 and Table 3-1 - In areas where contamination is left in place, a simple soil cover is not appropriate. In addition, the use of soil caps would require more in depth evaluation of ecological risk, since potential exposure to underlying contamination would be greater than with asphalt, concrete or a geosynthetic layer. Please remove any references to a soil cap.*

   The cover soil technology row has been screened from further consideration in Table 3-1. In addition, the reference to a single-layer soil cap has been removed from the bullet in Section 3.3.

9. *Alternative G-2 and Table 3-2 - The Natural Attenuation and Groundwater Sampling option was retained and was said to have demonstrated effectiveness. It is stated that attenuation of mercury would rely on dilution, dispersion, and transport, but this is not a desired outcome. Stopping the transport of mercury is a key goal of any selected remedy. When this remedy is evaluated it should state that it is not effective since there is potential for contaminated ground water to move off site.*

   For the Natural Attenuation/Groundwater Sampling row of Table 3-2, the effectiveness column (column 6) was revised from *"demonstrated"* to *"low."* In the typical monitored natural attenuation scenario, natural processes such as advection/dispersion, in situ reduction/precipitation, and/or adsorption are shown to render contaminants harmless by the time they reach a receptor(s). Because this scenario has not been demonstrated for a conservative substance such as mercury present in the groundwater at the Site, the phrasing was changed to *"low."* Column 9 (Screening Comments) was revised to state *"Potentially feasible for degradable COCs such as benzene. Attenuation of conservative substances, such as mercury and arsenic, would rely on non-biological processes including advection/dispersion, in situ reduction/precipitation, and/or adsorption"* to be consistent with the above discussion. The second paragraph, second sentence of subsection 5.4.2.1 has also been modified to read *"Based on the groundwater data collected in 2002, mercury, arsenic, and benzene have not migrated offsite and are not impacting the Diamond Shamrock/Henkel (north) Ditch or Berry's Creek.."* In addition, the following statement has been added to the ***Reduction of Toxicity, Mobility, and Volume through Treatment*** subsection (5.4.2.4): *"Groundwater Alternative G2 is not effective at reducing the potential for conservative contaminants, such as mercury and arsenic, to migrate off site."*

10. ***Table 3-2 - The remedy option of discharging untreated water to a POTW is said to be demonstrated effective and was retained. However, moving contaminated water off site should only be done if the water meets the POTW's pre-treatment requirements, or if the plant is specifically set up to treat mercury and the other contaminants. Please confirm this.***

Bergen County Utilities Authority (BCUA) has provisions for the discharge of groundwater to the POTW. The BCUA does not have local limits for mercury and arsenic, but refers to the NJDEP groundwater standards as a policy. Potential influent concentrations of mercury, benzene, and arsenic were calculated based on concentrations at nearby monitoring wells and the flow rate of the individual extraction well. Groundwater data from the 2002 groundwater sampling event were used to estimate the average mercury, benzene, and arsenic concentrations in influent groundwater. Details on the calculation are included in Table 4-6. For Groundwater Media Alternative G3, the expected mercury concentration is approximately 0.04 μg/L, which is lower than the 2 μg/L limit for NJDEP Groundwater Quality Criteria. The estimated benzene concentration (5.0 μg/L) is below the BCUA limit of 850 μg/L, and the potential arsenic (2.5 μg/L) concentrations are lower than the NJDEP limits of 8 μg/L. For Groundwater Media Alternative G4, the expected levels of mercury (4.0 μg/L) and arsenic (10.7 μg/L) are above the limits. Based on this information, the referenced description cell in Table 3-2 has been changed to *"treated groundwater"* from *"untreated water."*

11. ***Alternative S-2 and other Alternatives – Sampling of the soils below the West Ditch before and during the excavation should determine whether it is sufficient to remove only 1 foot of material. Additional excavation could be needed. The cover soils atop the liner will need to be checked and maintained regularly to be sure that runoff or storms do not affect the liner and that it will remain intact.***

Sampling costs are included in the costing assumptions and the Detailed Cost Tables in Appendix C for all areas in which excavation occurs, including the West Ditch. For cost estimation purposes, it was assumed that an average of one foot of material would be excavated from the West Ditch for Soil Alternatives S2 through S6. The specific design details of the West Ditch remediation and the sampling activities will be fully developed during the upcoming predesign and work planning phases. Inspection and maintenance of the West Ditch liner and cover is included in the semi-annual cover O&M activities.

12. ***Alternative S-2 and other Alternatives – The FS proposes to collect air samples for gaseous or particulate mercury from the Wolf Warehouse as part of the cap maintenance protocol. Samples would be collected at three locations and sampled on three occasions (year 1, 3, and 5) after completion of the remedial action. Sample results***

are proposed to be compared to the industrial risk-based concentration (RBC) limits. This proposal is not acceptable. In order to fully evaluate the potential risks, samples must be collected in the Wolf Warehouse for gaseous and particulate mercury during two seasons (summer and winter) during the first year of monitoring. The highest result of these two initial samples would then be used to determine the annual sampling season in years 3, 5, and thereafter. For costing purposes, the FS should assume that biennial air monitoring for gaseous and particulate mercury will be required for thirty years. This decision can be revisited at the time of the five-year review based upon sampling results. Finally, it is not appropriate to compare the results of the air samples to industrial RBC limits. Sample results should be compared to either the USEPA Region III ambient mercury criterion for residential exposure or a site specific risk based criterion developed in coordination with the regulatory agencies.

Indoor air samples for mercury will be collected during the summer and winter seasons for the first year. While the potential for particulate mercury concentrations indoors is unlikely, the proposed sampling method will be able to trap and analyze both particulate and vapor phase mercury concentrations. The mercury analytical results in air will be compared with residential RBC values - 0.31 $\mu g/m^3$ for mercury vapor and 1.1 $\mu g/m^3$ for particle-phase mercury. The results from biennial sampling will be reevaluated at the time of the five year review. For costing purposes in this FS, it is assumed that biennial monitoring for gaseous and particulate mercury will be required for 30 years. The assumptions in Soil Alternatives S2 through S6 have been revised to include the initial summer and winter analyses and then biennial events. The cost estimates in Appendix C have been revised to include the 30-year air monitoring period.

13. ***In all of the remedies that involve any removal or rearrangement of dirt or sediments, it should be explicitly stated that both pre-design and post-excavation samples are needed and will be collected. The agencies will need to approve the list of constituents that will be analyzed in the design and post-ex samples.***

In Soil Alternatives S2 through S7, the following assumption is included:

> *"A sampling allowance, based on cubic yards of excavated material, has been included to account for sampling activities and analytical costs related to conformance sampling. Specific sampling requirements developed during the work planning and predesign phases of the project will include pre-excavation and post-excavation confirmatory sampling as necessary based on agency review. Samples will be collected in accordance with NJDEP sampling procedures, and soil samples will be analyzed by a New-Jersey-certified laboratory."*

The work planning documents, which will require agency approval, will include the specific sampling approach, sampling methods, analytical methods, and constituent lists.

14. *The use of a mercury vapor meter might be helpful in determining the limits of excavation of hot spots, and should be used to screen all excavated soils or soil borings in addition to those samples that are selected for lab analysis.*

A mercury vapor meter (Jerome or equivalent) is typically used during intrusive excavation activities as a component of the health and safety monitoring activities for a site. Vapor meter readings are typically not directly correlated to solid phase concentrations because of the variety of mercury compounds that may be present in the soil. However, portable X-ray fluorescence (XRF) units are commonly used for field delineation of metal concentrations, including mercury, at metals-impacted sites. As stated in the response to comment No. 13, sampling methods and protocols will be developed in the work planning and pre-design phases of this project and may include use of a suitable, portable device to help delineate excavation limits.

15. *Fig 4-7 and Fig 4-11 – Some extraction wells should be installed towards the center of the site to help contain water from flowing offsite.*

Due to a reordering of the soil media and groundwater media alternatives, the referenced figures are now Figure 4-8 (formerly Figure 4-7) and Figure 4-10 (formerly Figure 4-11).

For Groundwater Alternative G3 (Hydraulic Controls via Pumping), the purpose of the five extraction wells is to intercept groundwater before entry to Berry's Creek, thus the wells are proposed for installation along the boundary with the creek banks. As described in the text of Groundwater Alternative G3, an initial modeling effort was undertaken to estimate the approximate number of wells and rate of pumping required to intercept downgradient flow from the site. The modeling effort and results are described in detail in the text. The text also states that the specifics of the groundwater extraction program, including number and locations of extraction wells, would be determined during predesign activities in conjunction with site pumping tests. The following statement has been added to Section 4.2, Groundwater Media Alternative 3 – Hydraulic Controls via Pumping, *Hydraulic Controls via Pumping* subsection, middle of third paragraph: *"If additional wells are shown to be necessary, they will be added."*

For Groundwater Alternative G4 (Groundwater Pump and Treat), details of the well locations and pumping rates would also be determined during predesign activities and during site pump tests. As discussed in the text, an initial modeling effort was undertaken to estimate the approximate number of wells and rate of pumping required to intercept downgradient flow from the site. The five extraction wells proposed in Groundwater Alternative G3 would be used to capture the downgradient edge of the plume. Two extraction wells in the area of the U.S. Life, and Wolf Warehouses, respectively, are proposed be installed to intercept the remainder of the contaminant plume. As with Groundwater Alternative G3, the number of extraction wells, locations of wells, and pumping rates will be finalized during the design phase to meet the conditions of a specific groundwater media alternative as selected in the ROD. The following statement has been added to Section 4.2, Groundwater Media Alternative 4—Groundwater Pump and Treat, *Collection via Pumping* subsection, middle of last paragraph: *"If additional wells are shown to be necessary, they will be added."*

16. ***Figure 4-9 - The proposed limited slurry wall is shown as a rectangle just around the Wolf Warehouse area. However, Figure 2-8 depicts the estimated zones of ground-water contaminants. These estimates seem reasonable based on what we know, so this treatment option should be designed to extend over all of the highly affected areas. However, this option does not account for the probable variability of the rest of the landfill materials in the bulk of the undeveloped area. The exact location of the wall would be determined during design and this should be mentioned in the FS.***

As stated above, the alignment of the vertical hydraulic barrier shown in Figure 4-12 (formerly Figure 4-9) was selected to contain the area where consistent exceedances of the mercury groundwater quality criteria have occurred (see Figure 2-8). Note that the plume contour on Figure 2-8 has been slightly modified based on a data transposition error discovered while reviewing data related to the response to comment No. 23. A complete discussion of groundwater contaminant levels outside of the proposed alignment of the vertical hydraulic barrier is presented in the response to comment No. 23. The alignment given in Figure 4-12 is shown for costing purposes. The precise location of the vertical hydraulic barrier will be determined during the design and may have minor modifications to the alignment shown to account for subsurface features (e.g., utilities, the Wolf Warehouse cutoff wall), surface features (e.g., the railroad spur to the south of the Wolf Warehouse, overhead power lines), and remedial actions required for the selected Soil Media Alternative. A statement to this effect is now included as the second sentence in the second to last paragraph in Groundwater Alternative G5.

17. ***Table 4-4 shows that only 6 of the 15 existing monitoring wells are proposed to be sampled. All 15 monitoring wells should be sampled for the next several years, and all remaining wells as modifications are made to the site. After the remedy has been implemented and ground-water concentrations are stable, the monitoring network can be reevaluated. As it is, the network is sparse and large areas of ground water are not monitored. Additional wells would be beneficial to monitor the remedy because the nature of the fill area is heterogeneous, and it is very possible that smaller contaminated source zones are present through the undeveloped area that have not yet been identified; the utility of additional wells should be considered during the remedial design.***

The following language has been added to Section 4.2 (Groundwater Media Alternative 2—Natural Attenuation and Institutional Controls, *Groundwater Monitoring* subsection, middle of first paragraph):

> *"For cost estimation purposes, it is assumed that the 15 existing monitoring wells (shown on Figure 2-8) will be monitored, assuming that they exist and are in good condition after the remedial action has occurred. The post-remediation monitoring network (number of wells, sampling locations, constituent analysis list) will be dependent on the final design. The utility of additional wells will be considered during the remedial design. After the remedy has been implemented and groundwater concentrations are stable, the monitoring network will be reevaluated. For costing purposes, it has been assumed that..."*

The costs in the Groundwater Media Alternatives Costs in Appendix C have been modified for Groundwater Media Alternatives G2 through G6 to be consistent with the assumption that 15 monitoring wells will be analyzed. The number of monitoring wells and piezometers, location, sampling frequency, and analyte list for sampling activities required to monitor the performance of the remedy would be addressed during the predesign and work planning phases.

18. ***Table 4-5 presents estimated flux rates to some surface water bodies adjacent to the site. However, the derivation of these values is not documented in the FS or in the RI report. It was not apparent which equations and input flow variables were used or what their observed ranges are at the site. It also seems to be inconsistent with the statement in the RI, page 5-6 bottom, that an analysis of migration rates from ground water to surface water bodies would involve a high degree of uncertainty and therefore would not be attempted at that time. Please include the range of results (assuming the reported values are average (or median?) values) and provide documentation on how these values were calculated.***

The following language has been added after the second paragraph of the *Natural Attenuation* subsection of Groundwater Media Alternative 2—Natural Attenuation and Institutional Controls of Section 4.2:

> *"The evaluation of fluxes of inorganics from groundwater through soil to Berry's Creek and the Diamond Shamrock/Henkel Ditch (north) was done following completion of the original draft of the RI. Because the RI is an investigation of the conditions that exist at the site, it was determined that a flux evaluation was not appropriate to include in that report. Because the FS is an evaluation of the impact that various remedial actions would have on the site, inclusion of the flux calculations is more appropriate for this document.*
>
> *The fluxes of inorganics from groundwater through soil to Berry's Creek and the Diamond Shamrock/Henkel Ditch (north) were estimated using the Dupuit equation for flow in an unconfined aquifer (Fetter, 1994) and represent pre-remediation conditions. Fluxes were estimated by multiplying the concentrations by the volume flow, which is a function of the hydraulic conductivity, the gradient and the width of the flow path. Hydraulic conductivities at the wells nearest to the surface water bodies were taken from Table 3-2 of the RI. Water elevations at the wells recorded from October 15, 1997 through June 19, 2000 (RI Table 3-1) were used with the depth to the clay/silt layer*

beneath the site (Ward, 1975) and the distances from the wells to Berry's Creek or the ditch to determine the gradients. The width of the flow paths between the wells is based on distances between the monitoring wells (RI, Figure 2-1a). Concentrations are taken from data collected in 1997 and 1999 (RI, Table B1-7a and B1-7e). Non-detect values were taken as being ½ the detection limit.

Average values for the parameters in the Dupuit equation were used to estimate fluxes. The range of hydraulic conductivity values is quite small, with maximum values being as much as 114% of the average. The range of gradient values is also small, with maximum values ranging up to 128% of the average. For mercury, the most current values (1999) were used in the flux calculations, so there is no difference between average and maximum values. Including the 1997 data, most of which are non-detect, would result in maximum mercury values as much as 9 times the average. For arsenic, maximum values range from 100% to 167% of the average values.

If one uses the maximum values for hydraulic conductivity, gradient and concentrations in the flux calculations, the following results are obtained:

Total flux to surface water:	*Mercury*	*Arsenic*
Current Conditions (without cap)		
Average Parameter Values	*41 g/yr*	*583 g/yr*
Maximum Parameter Values	*60 g/yr*	*971 g/yr*
Limited Recharge (with cap)		
Average Parameter Values	*2.2 g/yr*	*36 g/yr*
Maximum Parameter Values	*3.9 g/yr*	*69 g/yr*

Thus, using maximum values for all parameters, as opposed to average values, could result in fluxes of mercury and arsenic being from 1.5 to 2 times the fluxes based on average values."

The following reference has been added to Section 6:

Fetter, C. W. 1994. *Applied Hydrogeology, 3rd Edition*, Prentice-Hall, Inc., Upper Saddle River, NJ, page 164.

19. The Ecological Risk Characterization section indicates that an ecological risk assessment is on hold pending the completion of the Feasibility Study (FS). This statement is not accurate, and should be deleted. However, this section should provide a summary of the potential ecological risks at the site which were calculated in the Screening Level Ecological Risk Assessment (SLERA). Additionally, similar to the Human Health summary it should be noted that the Remedial Action Objectives (RAOs), Preliminary Remediation Goals (PRGs), and the remedial alternatives will address the potential ecological risks.

The statement that "*...an ecological risk assessment is on hold pending the completion of the Feasibility Study (FS)*" has been removed from the revised FS. The following language has been inserted to summarize the potential ecological risks at the site.

> "*The ERA assessed potential risks to ecological receptors from exposure to groundwater, surface soil in the undeveloped area, and surface water and sediment in the onsite basin and the West Ditch based on baseline conditions prior to any remediation. Maximum contaminant concentrations exceeded screening values in all media. The primary contaminant of concern is mercury, although other contaminants, notably chromium, lead, and zinc, are also potentially problematic. Refinement of the risk estimates (e.g., comparison to alternate screening benchmarks) still resulted in exceedances in all media except groundwater. Food chain models for top predators, consumers of soil invertebrates (e.g., earthworms), and consumers of fish and aquatic benthos indicated potential risks to all but the top predators; however, the food chain model for the top predators contains significant uncertainty concerning the estimation of contaminant concentrations in small mammal prey. Overall, the ERA found that a number of contaminants, notably mercury, in surface soil, sediment, and surface water pose risk to ecological receptors. Of potential risks, those to benthic invertebrates, other aquatic life, and earthworm predators such as the shrew and woodcock appear to be the most significant and most likely.*"

The RAOs and remedial alternatives for soil and groundwater presented in this FS address these potential ecological risks.

20. ***The PRGs developed for soil and groundwater appear to be based on human health data and, therefore, may not be appropriate for ecological receptors. Further information should be provided on how these PRGs will be protective of ecological receptors. A discussion of the cap preventing exposure would be useful. Additionally, it may be useful to include comparisons of concentrations of contaminants in groundwater to ecological screening values that are protective of ecological receptors, i.e., compare groundwater that will discharge to surface water to ambient water quality criteria.***

Although the PRGs for soil are not protective of ecological receptors, the asphalt cap proposed for the undeveloped fill area will effectively cut off the exposure pathway for ecological receptors, thus mitigating unacceptable risk in this area. The ecological risks in the developed area are discussed in response No. 21.

Monitoring wells (MW-1, MW-2, MW-3, MW-4, MW-5, MW-6, MW-12) in the undeveloped fill area that are outside of the limits of the proposed vertical hydraulic barrier (Groundwater Alternative G5) have not had levels of COCs that exceed the USEPA's National Recommended Water Quality Criteria (2006). These criteria and maximum contaminant levels detected in these wells are summarized in the following table, for sampling events in 1997, 1999, and 2002.

Chemical of Concern	NAWQC (μg/L)	1997 (max, μg/L)	1999 (max, μg/L)	2002 (max, μg/L)
Arsenic	150	14.6	u	12.2
Mercury	0.77	0.6	0.333	0.074
Benzene	5,300 / 46 *	u	9	NA

* Value based on AWQC (1994 listing); additional value of 46 μg/L published EcoTox Thresholds (EPA, 1996)
u – undetected
NA – not analyzed

21. ***Some of the soil remedial alternatives involve limited excavation and/or capping with institutional controls. However, since the institutional controls do not reduce ecological risks, further information should be provided regarding the protectiveness to ecological receptors, i.e., those alternative that do not include complete excavation or capping will not be protective of ecological receptors whereas those alternatives that include complete excavation or capping are protective.***

    The Ecological Risk Assessment (Exponent, April, 2001) states that "*Due to location in a developed area and its disturbed habitat, OU1 has marginal habitat for ecological receptors.*" Furthermore, the properties in the developed area "*...are primarily beneath pavement or crushed stone in railroad beds, precluding current exposure to ecological receptors.*" Most properties in the urbanized, developed area (Wolf, U.S. Life, EJB, Lin-Mor, Borough of Wood-Ridge) have existing asphalt caps and/or will have upgrades to these caps completed as part of the various Soil Media Alternatives. For the Blum and Prince Packing properties in the developed area, there are very minimal areas with RDCSCC exceedances that are currently landscaped. These extremely limited areas support very few or no ecological receptors and they are isolated (i.e., ecologically disconnected) within an urban landscape. For the undeveloped fill area, beginning with Soil Alternative 2, the exceedance areas will be excavated and replaced with certified clean fill and/or capped (asphalt for the interior of the undeveloped fill area, geomembrane liner for the West Ditch). These remedial measures will address potential risks to ecological receptors by eliminating or significantly reducing exposure to contaminated soil.

22. ***The soil remedial alternatives that include capping the West Ditch should provide information on how ground water discharge to the ditch will be handled since this discharge may not be compatible with the planned impermeable liner.***

    The West Ditch is a tidally-influenced water body, which is dry or contains very little water during low tide events and is wet during high tide events. In addition, the West Ditch conveys surface water from the Developed Area during precipitation events. During the design and work planning phases, groundwater impacts to the West Ditch will be assessed and the liner system designed accordingly.

23. ***Groundwater Media Alternative 4 involves a vertical hydraulic barrier to contain areas associated with elevated mercury concentrations. It may be useful to provide information regarding the magnitude of concentrations of site-related contaminants in groundwater outside the proposed vertical hydraulic barrier and whether those concentrations would meet the RAOs.***

Due to a reordering of Groundwater Media Alternatives (see response to comment No. 26), the Vertical Hydraulic Barrier alternative is now numbered as Groundwater Alternative 5. The maximum concentrations of arsenic, benzene, and mercury in groundwater for those wells located outside and downgradient of the proposed vertical hydraulic barrier in Groundwater Media Alternative 5 are stated in the response to comment No. 20. Based on a review of the groundwater contaminant levels summarized in the RI, the position of the contour for groundwater PRG exceedances (all COCs) in Figure 2-8 has been slightly modified due to a data transposition error. The arsenic concentration of 12.2 μg/L was detected in a sample drawn from MW-6, not from MW-14. In addition, the benzene concentration of 1.2 μg/L was obtained from a sample drawn from MW-5, not MW-6. The new position of the plume contour shown in the revised Figure 2-8 has limited impact on the ability to meet RAOs, as discussed below:

- Arsenic has been recorded above its PRG value of 8 μg/L in MW-6 in 1997 (13.8 μg/L) and 2002 (12.2 μg/L). The area where MW-6 is located is proposed for excavation to 4 feet below ground surface beginning with Soil Media Alternative 3; thus, the probable limited source of arsenic contamination from historical fill in this area will be excavated, treated, and disposed off site.

- Mercury has not been recorded above its PRG value of 2 μg/L in monitoring wells MW-1, MW-2, MW-3, MW-4, MW-5, MW-6, and MW-12. The highest concentration of mercury in these wells is consistently in MW-5, where levels have been consistently decreasing since 1997 (0.6 μg/L in 1997, 0.333 μg/L in 1999, 0.074 μg/L in 2002).

- Benzene, a degradable compound, was recorded above its PRG of 1 μg/L in MW-5 in 1999 at a level of 1.2 μg/L and in MW-2 (located in the center of the undeveloped fill area) at a level of 9 μg/L, also in 1999.

These COC concentrations in monitoring wells located outside of the proposed vertical hydraulic barrier in Groundwater Media Alternative 5 are all below the ecologically-based NAWQC standards of 150 μg/L for arsenic, 0.77 μg/L for mercury, and 46 μg/L for benzene (see response to comment No. 20).

24. ***The Overall Protection of Human Health and the Environment section should include information regarding the potential for soil with concentrations that exceed ecological benchmarks to remain available to ecological receptors after the Remedial Alternatives have been conducted (i.e., for those alternatives that do not include complete removal or capping). This issue should be incorporated into the evaluation of whether the Alternative is ecologically protective.***

    The Ecological Risk Assessment (Exponent, April, 2001) states that *"Due to location in a developed area and its disturbed habitat, OU1 has marginal habitat for ecological receptors."* Furthermore, the properties in the developed area *"...are primarily beneath pavement or crushed stone in railroad beds, precluding current exposure to ecological receptors."* For the undeveloped fill area, beginning with Soil Alternative 2, the area will be capped with asphalt and a geomembrane liner will be placed in the West Ditch. In addition, various exceedance areas will be excavated and replaced with certified clean fill. The following statement is placed in the Overall Protection of Human Health and the Environment (Subsection 5.3.2.1) *"Furthermore, soil with concentrations that exceed ecological benchmarks do not remain available to ecological receptors after the remedial alternatives have been conducted because each alternative (except Soil Alternative S1, the No Action Alternative) includes capping with an asphalt cap, or removal."*

25. ***The discussion of the collection and ex-situ treatment of groundwater in the Overall Protection of Human Health and the Environment section indicates that the pumping would likely deprive the wetland and Berry's Creek of a primary water source. The section also indicates that this issue should be investigated further during pre-design studies and/or pilot tests. However, without any supporting data the statements indicating that "pumping would likely deprive the wetland and Berry's Creek of a primary water source" or it "is not considered a practical groundwater alternative" may not be appropriate.***

    Without results from actual pilot tests and/or modeling efforts, the statement of *"...the high volume pumping would likely deprive the wetland and Berry's Creek of a primary water source"* has been revised to *"...pumping along the perimeter of the undeveloped fill area adjacent to Berry's Creek and the OU2 wetlands may cause a change in the groundwater gradients in the vicinity of the extraction wells."* In addition, the statement *"...is not considered a practical groundwater alternative..."* has been modified to *"Impacts to the natural resources in the areas of the extraction pumping within Groundwater Alternative G4 would be investigated further during the design phase of the project."*

26. ***The document must also be revised as per the Department's email to Rohm and Haas dated January 27, 2006. This email outlined the seven remedial alternatives for soil that should be considered as well as other comments.***

a. *No letters of consent to a deed notice were included from Lin-Mor or Prince Packing. Therefore, no alternatives can include leaving contamination above RDCSCC for site related COCs on these properties All soil alternatives, aside from no action (which is required as a baseline for comparison purposes), must be revised to state that Lin-Mor and Prince Packing will be remediated to RDCSCC. Note that the Department may provide flexibility in the proposed plan and ROD... if a deed notice/consent can be provided for a property we may allow for contamination to be left behind (the reverse will then be written in the ROD also – if a draft deed notice and property owner's written agreement to record the deed notice cannot be provided in the remedial action work plan then those properties must be remediated to the RDCSCC.*

   A letter of consent to a deed notice for the Prince Packing property was obtained from Mr. Berger on February 03, 2006, and is included in Appendix E of the revised Feasibility Study. A copy of this letter was forwarded via e-mail to the DEP on February 03, 2006. The Feasibility Study has been modified, for cost estimating purposes, to include a 450-foot-long, 20-foot-wide, 2-foot-deep excavation zone running parallel to the railroad spur owned by Norfolk Southern. This proposed excavation covers the area with levels of COCs (specifically lead and mercury) above the RDCSCC on the Lin-Mor property. The location of the excavation area is shown starting with Figure 4-1 of the FS. Soil Alternatives S2 through S7 each include the excavation of this area for either placement in the undeveloped fill area followed by capping (S2 through S5) or for transport to an appropriate offsite disposal facility (S6 and S7). The cost estimates (Appendix C) have been revised to include the costs for this activity, including the demolition of asphalt, excavation, backfill, and asphalt replacement in this area. Actual volumes and areas of excavations will be determined during the predesign phase.

b. *Alternative 3A from the 5/13/05 FS was selected in the draft proposed plan and it consisted of excavation of soils with mercury over 620 ppm in the developed and undeveloped areas and excavation on the Blum and Prince Packing properties. Alternative 3 consisted of excavation of soils with mercury over 620 ppm in the undeveloped area and excavation on the Blum and Prince Packing properties. Alternative 3A in the current FS consists of excavation of soils with mercury over 620 ppm in the developed and undeveloped area with no excavation of the Blum and Prince Packing properties (i.e., a change from the original 3A which had excavation on Blum and Prince). Alternative 3 consists of excavation of soils with mercury over 620 ppm in the undeveloped area and excavation of mercury contaminated soils down to 14 ppm on the Blum, Prince Packing and Lin-Mor properties (this is what the text says...the map shows Lin-Mor not being excavated). Alternative 3B consists of excavation of soils over 620 ppm on the developed and undeveloped area, and excavation of the Lin-Mor property (this was submitted per DEP request since a deed notice commitment letter was not submitted for Lin-Mor). The current FS does not provide an alternative equivalent to the 5/13/05 FS alternative 3A, i.e.,* *excavation of soils over 620 ppm in the developed and undeveloped areas and excavation of Blum, Prince Packing, and Lin-Mor. The agencies did not request that this change be made, and it is inappropriate that this was done in the revision without it being noted in the cover letter. This alternative must be included.*

See response to comment c, below.

c. *Typically a FS has alternatives that range from least intrusive/expensive (i.e., no action) to most intrusive/expensive (e.g., full excavation). With that in mind, for this site, the alternatives should be 1) no action; 2) use restrictions with no excavation for properties with deed notice concurrence and excavation for Lin-Mor and Prince to RDCSCC; 3) excavation of undeveloped area above 620 ppm mercury, Lin-Mor and Prince to RDCSCC and deed notices for other properties; 4) excavation of undeveloped and developed areas above 620 ppm mercury, Lin-Mor and Prince to RDCSCC and deed notices for other properties; 5) excavation of undeveloped and developed areas over 620 ppm mercury, and all other properties to RDCSCC; 6) excavation of undeveloped area and all other properties other than developed area to RDCSCC, deed notice on developed area; and 7) excavation of undeveloped, developed, and all other properties to the RDCSCC.*

The soil (and groundwater) alternatives have been reordered and modified to include the proposed progression of alternatives from least intrusive to most intrusive. The titles of the soil alternatives have been changed to capture the key elements within each of the reordered alternatives, as follows:

- Soil Alternative 2 – Use Restrictions for Properties with Deed Notice Concurrence and Limited Excavation to RDCSCC
- Soil Alternative 3 – Excavation of Undeveloped Area with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC
- Soil Alternative 4 – Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC
- Soil Alternative 5 – Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Excavation of Other Properties to RDCSCC, and Use Restrictions on Undeveloped and Developed Areas
- Soil Alternative 6 – Excavation of Developed Area with ≥ 620 mg/kg Mercury, Excavation of Undeveloped Area and Other Properties to RDCSCC, and Use Restrictions on Developed Area
- Soil Alternative 7 – Excavation of Undeveloped, Developed, and Other Properties to RDCSCC and Use Restrictions on the Railroad

References to capping, the West Ditch Rehabilitation, the 55-foot Soil Buffer, Treatment/Stabilization, and Offsite Disposal are not included in the soil alternative titles because they are inclusive to most alternatives. The text in the FS, the accompanying figures and tables, and the cost estimates fully describe these additional components within each alternative. Tables 4-2 specifically summarizes which remediation components are included in each soil alternative for each property at the site. As requested by DEP, Table 5-2 is a new table in the FS (existing Table 5-2 becomes Table 5-3) and consists of a matrix of soil components for each property.

The Groundwater Alternatives have also been reordered to be consistent with the least intrusive to most intrusive philosophy, as follows:

- Groundwater Alternative G1—No Further Action
- Groundwater Alternative G2—Natural Attenuation and Institutional Controls
- Groundwater Alternative G3—Hydraulic Controls via Pumping
- Groundwater Alternative G4—Groundwater Pump and Treat
- Groundwater Alternative G5—Vertical Hydraulic Barrier
- Groundwater Alternative G6—Vertical Hydraulic Barrier Around Site Perimeter

Similar to Table 5-2, a new table (Table 5-4) has been included in the FS, which is a matrix of groundwater components.

The reordering of the soil and groundwater alternatives, combined with new components of some alternatives and new information received on property ownership and deed notice concurrence, have necessitated substantial changes in the FS. To foster an expedient review of these changes, the following is a summary of the locations within the FS that have received these changes:

<u>Table of Contents</u>

- The figures in Section 4 have been reordered to account for the new progression of alternatives. As discussed previously, the titles of the Soil Alternatives have also been revised.

- Two new tables have been added (5-2 and 5-4). Existing Table 5-2 has been renumbered to Table 5-3. Tables 5-2 and 5-4 are the matrices of soil and groundwater components specific to each property on the site.

<u>Introduction</u>

- The acreage of the Developed Area has been modified to include the acreage of the Lin-Mor property.

- In the footnote on page 1-4, a sentence has been added to include the Lin-Mor property as a target area within the OU1 FS.

- In Table 1-1, the railroad property owner (Block 332, Lot 2) has been corrected to "*Norfolk Southern*" to be consistent with the current owner of this railroad spur located parallel to Ethel Boulevard. For consistency, references to this property in the remainder of the figures and text in the FS have been corrected to "*Norfolk Southern.*"

<u>Section 2</u>

- Subsection 2.1.1.2, LDR Considerations, has been replaced in its entirety with revised LDR text. The new language is the same version submitted to the DEP on January 27, 2006, via e-mail, for review and acceptance.

<u>Section 3</u>

- The second bullet on page 3-8 has been slightly modified to "*Monitoring (soil sampling, predesign investigations, and/or air sampling).*"

<u>Section 4</u>

- The alternatives and figures in Section 4 have been reordered to account for the new progression of alternatives. As discussed previously, the titles of the Soil Alternatives have also been revised.
- Alternative S2 – Added the component of excavation on the Lin-Mor property for placement in the undeveloped fill area. Specific reference to the RDCSCCs of site COCs (mercury, lead, and arsenic) is added. The bullet on stabilization of excavated soil containing hazardous waste was removed because excavated soil from this alternative is not expected to be characteristically hazardous. This alternative now has 8 deed notices proposed (Blum, Prince, EJB, Norfolk Southern, U.S. Life, Wolf, Borough of Wood-Ridge, undeveloped fill area).
- Alternative S3 – In the opening paragraph, part (6), excavation from Blum and Prince Packing properties has been removed. Excavation (soil) bullet has been modified to "*Excavation (Soil from Lin-Mor and Undeveloped Fill Area).*" In the Asphalt Cap (Existing) subsection, reference to a cap on the Lin-Mor property is removed because this area will be excavated. References to excavations on the Blum and Prince Packing properties removed (Single Layer Cap subsection, Excavation (Soil) subsection, and in the assumption bullets). Similar to Alternative S2, 8 Deed Notices proposed.
- Alternative S4 – This alternative was formerly the S3A alternative. In the opening paragraph, part (5), excavation on the Lin-Mor property added. The subsection on the Asphalt Cap (Existing) modified to exclude Lin-Mor because this is now being excavated in this alternative. Like S3 and S4, this alternative has 8 Deed Notices.

- Alternative S5 – This is a 'new' alternative, but is similar to the Soil Alternative 3B delivered to DEP on January 10, 2006, as an addendum to the January 5, 2006, FS submittal. This soil alternative includes all of the components of S4, in addition to the excavation to RDCSCC on the "Other Properties," including the Borough of Wood-Ridge, EJB, Blum, Prince Packing, and Lin-Mor properties. For Ethel Boulevard, a shallow excavation to 2 feet is assumed and the proposed cap section (Figure 4-2) would be implemented for the reconstruction of the street as well. Curb and gutter would also be added.

- Alternative S6 – This alternative was formerly the S4 alternative in the January 5, 2006, FS submittal. Excavation on the Lin-Mor and Borough of Wood-Ridge streets has been incorporated. Land Use Restrictions only for U.S. Life, Wolf Warehouse, and Norfolk Southern because all other properties excavated to RDCSCC. Excavation (soil) subsection modified to include the excavations on the Lin-Mor and Borough of Wood-Ridge properties.

- Alternative S7 – This alternative was formerly the S5 alternative in the January 5, 2006, FS submittal.

<u>Section 5</u>

- Based on the reordering of the soil and groundwater media alternatives, the relative comparison of alternatives have been revised to ensure consistency of discussions between alternatives. In addition, revisions have been made, as suggested, to respond to specific agency comments (those parts of comments No. 1 through 25 that specifically impact Section 5).

- The time frame for each soil alternative and the number of loads of soil delivered to or from the site have been updated based on anticipated excavation/backfill production rates, treatment capacity limitations at the receiving landfill(s), and other estimated construction timeframes (e.g., paving activities).

<u>Tables</u>

- Table 1-1 - Removed Block 332, Lot 1 property (NY and NJ RR) information because this property is not part of the defined Developed Area. Block 332, Lot 2 owner changed to 'Norfolk Southern' to be consistent with most recent control and ownership of this property. In the Block 229, Lot 1 row, removed 'NY & NJ RR and Commerce' because this lot is completely owned by Julius Blum and Company.

- Table 3-1 - Containment – Cover – Soil row screened out per NJDEP/EPA comments. Ex Situ Treatment – Physical/Chemical – Soil Washing and Retorting rows now carried forward per NJDEP/EPA comment.

- Table 3-2 - Natural Attenuation row revised per comment No. 9. Discharge – Sewer – POTW row revised per comment No. 10.
- Tables 4-1, 4-2, 4-3, 5-1, and 5-3 (previously 5-2). Columns updated to incorporate new order of alternative presentation and the components of each of these alternatives.
- Tables 5-2 and 5-4 - New tables prepared at the request of NJDEP. The tables compare the Soil and Groundwater Media Alternatives, by property.

Figures

- New Soil and Groundwater Alternative titles have been updated based on the new order of alternatives.
- Global Changes. Legends revised to provide a consistent presentation order of the symbols/legends used across all figures. Recently constructed buildings on the Lin-Mor property have been added. Each title has the following information: Ventron/Velsicol Superfund Site, OU1 Feasibility Study, Date.
- Figure 1-1 - Site boundary outline modified to include the properties north of Ethel Blvd.
- Figure 1-2 - Developed Area limits have been revised to include the Lin-Mor property. Property lines added. The subdivision of Block 229, Lot 4 into two properties, including the Lin-Mor property to the south, has been added.
- Figure 4-1, 4-3 through 4-7 - Property boundaries added. Alternative shading revised to update the remedial components included based on the reordering and revisions to the Soil Media Alternatives. Consistent hatching symbols used for all Soil Alternatives.
- Figure 4-8 through 4-13 - Reordered per changes to the Groundwater Media Alternative ordering.

Cost Tables

- The 'Comparison of Total Cost' sheet has incorporated the new alternative titles, new alternative ordering, and the capital and O&M costs have been revised to account for the reordering, the inclusion of different excavation/capping sequences, and O&M changes due to change in areas of caps and the air monitoring frequency and duration.

- Global changes to Soil Alternatives S2 through S7 - In the notes column, each line item specifically referenced to a source, including (1) MEANS estimate (Unit Cost Worksheet), (2) Source 3 (quotes and/or estimates from vendors or contractors based on similar projects, or (3) Source 4 (construction takeoff estimate). Air monitoring has been extended to biennial basis for 30 years. Sampling, analytical, environmental controls and health and safety considerations for each alternative are grouped together where these costs were previously components of different groupings of remedial actions. The heading for this grouping is titled "Compliance Monitoring and Health & Safety." The duration of each alternative also revised based on new projections for the components of each alternative.

- Global Changes, continued - Error in the formula for the square yardage of the 2 coat seal coating in the Developed Area corrected. Unit pricing in the "supply and installation of vegetation" for the West Ditch corrected to a unit pricing based on acreage. Unit cost for placing clean backfill and revegetating the 55-ft Buffer converted to a lump sum basis based on a detailed construction takeoff estimate included in Source 4.

- Soil Alternatives S4 through S6 - Utility Maintenance/Repair and Drainage improvement for excavation activities on the U.S. Life/Wolf properties included (previously not accounted for).

- Soil Alternative S6 - Clearing and grubbing extended to 19.1 acres.

- Soil Alternative S7 - Cubic footage of building demolition corrected to 3,966,000 cubic yards. Added an estimate of $200,000 to account for the decommissioning and removal of utility runs to the U.S. Life and Wolf Warehouses. Added rows to account for mulching and vegetation of the Undeveloped Fill Area.

- Unit Cost Worksheet - Additional unit cost information (Source 3) expanded to state estimate basis for comprehensive list of derived unit costs.

- Health and Safety and Production Worksheet - Excavation and backfill volumes revised to remain consistent with reordered sequence of alternatives and to reflect weekly capacity limits at hazardous waste landfill to accept/treat/dispose of contaminated material from the site. Estimates for required truck visits to/from site and construction time periods revised to be consistent with activities/volumes within each alternative.

Please do not hesitate to call me should you have any questions following your review of this report.

Sincerely,

Walanski

Kenneth Walanski
Remediation Projects Manager

c: Doug Tomchuk, USEPA, Region 2
Margaret Bazany, Rohm and Haas Company

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ROHM AND HAAS

CERTIFICATION STATEMENT

I certify under penalty of law that I have personally examined and am familiar with the information herein and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant civil penalties for knowingly submitting false, inaccurate, or incomplete information and that I am committing a crime of the fourth degree if I make a written false statement which I do not believe to be true. I am also aware that if I knowingly direct or authorize the violation of any statute, I am personally liable for the penalties.

For Morton International, Inc.

By:

Walanski
Signature

Kenneth Walanski
Printed Name

Remediation Projects Manager
Title

Morton International, Inc.
Company

4-4-2006
Date

Appendix A
ARARs

Appendix A
Potential Chemical-Specific ARARs

Act/Authority	Criteria/Issues	Citation	Brief Description	Prerequisite
Federal Safe Drinking Water Act	National Primary Drinking Water Standards - Maximum Contaminant Level Goals (MCLGs) and Maximum Contaminant Levels (MCLs)	40 CFR 141	Establishes health-based standards for public drinking water systems. Also establishes drinking water quality goals set at levels at which no adverse health effects are anticipated, with an adequate margin of safety. The NCP specifically states that MCLs will be used as ARARs for useable aquifers rather than the more stringent MCLGs.	TBC. Considered relevant and appropriate because the site is near surface waters that are used for public water supplies. Currently, groundwater at the site is not anticipated to be used.
Federal Safe Drinking Water Act	National Secondary Drinking Water Standards-Secondary MCLs	40 CFR 143	Establishes standards for public drinking water systems for those contaminants which impact the aesthetic qualities of drinking water.	TBC. Secondary MCLs are based on aesthetic criteria and do not reflect public health concerns. They are considered TBCs and will be attained where possible.
Quality Criteria for Water	Water Quality Criteria	40 CFR 131 Quality Criteria for Water, 1976, 1980, and 1986	Sets criteria for water quality based on toxicity to human health.	TBCs. If water is discharged to surface water, these are used in setting effluent discharge limits.
Federal Resource Conservation and Recovery Act	Groundwater Protection Standards and Maximum Concentration Limits	40 CFR 264, Subpart F	Establishes standards for groundwater protection for several metals and pesticides.	ARARs. These maximum concentration limits are applicable to RCRA regulated units and are considered relevant and appropriate to the Ventron/Velsicol site.
Federal Clean Air Act	National Ambient Air Quality Standards	40 CFR 50	Establishes emission limits for six pollutants (SO_2, PM_{10}, CO, O_3, NO_2, and Pb).	TBC. Emissions could be produced during treatment processes, however, are not expected to be a major source.

Appendix A
Potential Chemical-Specific ARARs

Act/Authority	Criteria/Issues	Citation	Brief Description	Prerequisite
State of New Jersey Statutes and Rules	Drinking Water Standards-Maximum Contaminant Levels (MCLs)	N.J.A.C. 7:10 Safe Drinking Water Act	Establishes MCLs that are generally equal to or more stringent than the SDWA MCLs.	ARARs. Although there are no local receptors and all properties are served by city water, the underlying aquifer is a potential drinking water supply source.
State of New Jersey Statutes and Rules	National Secondary Drinking Water Standards-Secondary MCLs	N.J.A.C. 7:10-7 Safe Drinking Water Act	Establishes standards for public drinking water systems for those contaminants which impact the aesthetic qualities of drinking water.	TBC. Secondary MCLs are based on aesthetic criteria and do not reflect public health concerns. They are considered TBCs in that they will be attained where possible.
State of New Jersey Statutes and Rules	Groundwater Quality Standards	N.J.A.C. 7:9-6 Groundwater Quality Standards	Establishes standards for the protection of ambient groundwater quality. Used as the primary basis for setting numerical criteria for groundwater cleanups.	ARARs.

Appendix A
Potential Action-Specific ARARs

Act/Authority	Criteria/Issues	Citation	Brief Description	Prerequisite
Discharge of Groundwater or Wastewater				
Federal Clean Water Act	National Pollution Discharge Elimination System (NPDES)	40 CFR 122 and 125	Issues permits for discharge into navigable waters. Establishes criteria and standards for imposing treatment requirements on permits.	ARAR although state ARAR takes precedence for discharge permit. Disposal of groundwater to the surface water. NPDES permit may not be required since New Jersey has an approved SPDES permit program (NJDPES).
Federal Clean Water Act	General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR 403	Prohibits discharge of pollutants to a POTW which cause or may cause pass-through or interference with operations of the POTW.	ARAR. Discharge to pollutants including those that could cause fire or explosion or result in toxic vapors or fumes to POTW.
Federal Clean Water Act	Effluent Guidelines and Standards for the Point Source Category	40 CFR 414	Requires specific effluent characteristics for discharge under NPDES permits.	ARAR although state ARAR takes precedence for discharge permit. Disposal of groundwater to the surface water. NPDES permit may not be required since New Jersey has an approved SPDES permit program (NJDPES).
Federal Safe Drinking Water Act	Underground Injection Control Program	40 CFR 144	Establishes performance standards, well requirements, and permitting requirements for groundwater re-injection wells.	Discharge of treated groundwater to potable water supply aquifer. May also apply to the injection of surfactants or oxidants into the aquifer. Alternatives do not include underground injection.
Federal Clean Water Act	Ambient Water Quality Criteria	40 CFR 131.36	Establishes criteria for surface water quality based on toxicity to aquatic organisms and human health.	Groundwater discharge to surface water. Federally-approved New Jersey groundwater and surface water standards take precedence over the Federal criteria.
Federal Clean Water Act	Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredge or Fill Material; Section 404 (c) Procedures; 404 Program Definitions; 404 State Program Regulations	40 CFR 230-233	Restricts discharge of dredged or fill material to wetlands or waters of the United States. Provides permitting program for situations with no other practical alternative.	ARAR because wetlands are on site and are anticipated to be affected by remediation.
Federal Clean Water Act	Water Quality Criteria Summary		Includes non-promulgated guidance values for surface water based on toxicity to aquatic organisms and human health. Issued by the EPA office of Science and Technology, Health and Ecological Criteria Division.	Groundwater discharge to surface water. Supplements above-referenced Ambient Water Criteria.

Appendix A
Potential Action-Specific ARARs

Act/Authority	Criteria/Issues	Citation	Brief Description	Prerequisite
State of New Jersey Statutes and Rules	The New Jersey Pollutant Discharge Elimination System	N.J.A.C. 7:14A The New Jersey Pollutant Discharge Elimination System	Establishes standards for discharge of pollutants to surface and groundwater.	ARAR. New Jersey has a state approved program. Disposal of treated groundwater to surface water.
State of New Jersey Statutes and Rules	Groundwater Quality Standards	N.J.A.C. 7:9-6 Groundwater Quality Standards	Establishes standards for the protection of ambient groundwater quality. Used as the primary basis for setting numerical criteria for groundwater cleanups and discharges to groundwater.	ARAR. Disposal of treated groundwater by reinjection.
State of New Jersey Statutes and Rules	Surface Water Quality Standards	N.J.A.C. 7:9B Surface Water Quality Standards	Establishes standards for the protection and enhancement of surface water resources.	ARAR. Disposal of treated groundwater by discharge to surface water.
Disposal of Hazardous Waste				
Federal Resource Conservation and Recovery Act	Identification and Listing of Hazardous Waste	40 CFR 261	Identifies solid wastes which are subject to regulation as hazardous wastes.	ARAR. Generation of a hazardous waste possibly including spent carbon or contaminated soil. Hazardous waste must be handled and disposed of in accordance with RCRA. Chemical testing and characterization of waste required.
Federal Resource Conservation and Recovery Act	Standards Applicable to Generators of Hazardous Waste	40 CFR 262	Establishes requirements (e.g., EPA ID numbers and manifests) for generators of hazardous waste.	ARAR. Waste that is characterized as hazardous.
Federal Resource Conservation and Recovery Act	Standards Applicable to Transporters of Hazardous Waste	40 CFR 263	Establishes standards which apply to persons transporting manifested hazardous waste within the United States.	ARAR. Transport of waste that is characterized as hazardous.
Federal Resource Conservation and Recovery Act	Standards Applicable to Owners and Operators of Treatment, Storage and Disposal Facilities	40 CFR 264	Establishes the minimum national standards which define acceptable management of hazardous waste.	Generation and storage of hazardous waste. May not apply to remediation sites if owner complies with requirements listed in 264, 1(j).
Federal Resource Conservation and Recovery Act	Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR 265	Establishes minimum national standards that define the periods of interim status and until certification of final closure or if the facility is subject to post-closure requirements, until post-closure responsibilities are fulfilled.	Remedies should be consistent with the more stringent PART 264 standards, as these represent the ultimate RCRA compliance standards and are consistent with CERCLA's goal of long-term protection of public health and welfare and the environment.

Act/Authority	Criteria/Issues	Citation	Brief Description	Prerequisite
Disposal of Hazardous Waste (continued)				
Federal Resource Conservation and Recovery Act	Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities	40 CFR 267	Establishes minimum standards that define acceptable management of hazardous wastes for new land disposal facilities.	Remedies should be consistent with the more stringent PART 264 standards, as these represent the ultimate RCRA compliance standards and are consistent with CERCLA's goal of long-term protection of public health and welfare and the environment.
Federal Resource Conservation and Recovery Act	Land Disposal Restrictions	40 CFR 268	Identifies hazardous wastes which are restricted from land disposal. All listed and characteristic hazardous waste or soil or debris contaminated by a RCRA hazardous waste and removed from a CERCLA site may not be land disposed until treated as required by LDRs.	ARAR. Waste disposed as a RCRA waste.
Federal Resource Conservation and Recovery Act	Hazardous Waste Permit Program	40 CFR 270	Establishes provisions covering basic EPA permitting requirements.	A permit is not required for on-site CERCLA response actions. Substantive requirements are added in 40 CFR 264.
State of New Jersey Statutes and Rules	Hazardous Waste	N.J.A.C. 7:26C Hazardous Waste	Establishes rules for the operation of hazardous waste facilities in the state of New Jersey	Potential ARAR is New Jersey facility used for treatment of generated hazardous wastes.
Federal Resource Conservation and Recovery Act	RCRA	40 CFR 265	Establishes organic air emission standards for tanks, surface impoundments, and containers.	Applicable to hazardous waste treatment, storage, and disposal facilities (TSDFs) that receive new or re-issued permits or Class 3 modifications after 5 January 1995.
Federal Hazardous Material Transportation Act	Hazardous Materials Transportation Regulations	49 CFR 107, 171-177	Regulates transportation of hazardous materials.	An ARAR because response action would involve transportation of hazardous materials.
General Remediation				
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and Superfund Amendments and Reauthorization Act of 1986 (SARA)	National Contingency Plan	40 CFR 300, Subpart E	Outlines procedures for remedial actions and for planning and implementing off-site removal actions.	ARAR.

Appendix A
Potential Action-Specific ARARs

Act/Authority	Criteria/Issues	Citation	Brief Description	Prerequisite
General Remediation (continued)				
State of New Jersey Statutes and Rules	Technical Requirements for Site Remediation	N.J.A.C. 7:26E Technical Requirements for Site Remediation	Established minimum regulatory requirements for investigation and remediation of contaminated sites in New Jersey.	ARAR.
Federal Occupational Safety and Health Act	Worker Protection	29 CFR 1904	Requirements for recording and reporting occupation injuries and illnesses	ARAR. Under 40 CFR 300.38, requirements of OSHA apply to all activities which fall under jurisdiction of the National Contingency Plan.
Off-Gas Management				
Federal Clean Air Act	National Primary and Secondary Ambient Air Quality Standards	40 CFR 50	Establishes emission limits for six pollutants (SO2, PM10, CO, O3, NO2, and Pb).	Emission of ozone (O3) may be of concern for some remedial technologies utilizing ozone as an oxidizing agent. National limit is 8-hour, 0.08 ppm standard. However alternatives do not include use of ozone.
Federal Clean Air Act	Standards of Performance for New Stationary Sources	40 CFR 60	Provides emissions requirements for new stationary sources.	ARAR since on-site treatment may be required to meet LDRs for generated soil.
Federal Clean Air Act	National Emission Standards for Hazardous Air Pollutants	40 CFR 61	Provides emission standards for 8 contaminants including benzene and vinyl chloride. Identifies 25 additional contaminants, as having serious health effects but does not provide emission standards for these contaminants.	ARAR.
State of New Jersey Statutes and Rules	Standards for Hazardous Air Pollutants	N.J.A.C. 7:27 Air Pollution Control	Rule that governs the emitting of, and such activities that result in, the introduction of contaminants into the ambient atmosphere.	ARAR.

Appendix A
Potential Location-Specific ARARs

Type	Act/Authority	Criteria/Issues	Citation	Brief Description	Prerequisite
Within 100-Year Floodplain	New Jersey Flood Hazard Control Act	Floodplain Use and Limitations	N.J.A.C. 7:13 Flood Hazard Area Control	State standards for activities within flood plains.	An ARAR for those aspects of the site work that are within the flood plains.
Within 100-Year Floodplain	Federal National Environmental Policy Act (NEPA)	Statement of Procedures on Floodplain Management and Wetlands Protection	40 CFR 6, Appendix A	Establishes EPA policy and guidance for carrying out Executive Order 11988 - Protection of Floodplains and Executive Order Action must avoid adverse effects, minimize potential harm and restore and preserve natural and beneficial values of the floodplain.	Action will occur in a floodplain (lowlands and relatively flat areas adjoining inland) and coastal water and other flood-prone areas.
Wetlands	New Jersey Freshwater Protection Act		N.J.S.A. 13:9B-1; N.J.A.C. 7:7A	Require permits for regulated activity disturbing wetlands.	ARAR because wetlands are on site and are anticipated be affected by remediation.
Area Affecting Stream or River	Coastal Area Facility Review Act Permit	Statement of procedures for work within coastal areas.	N.J.S.A. 13:19-1 et seq.)	Establishes that coastal areas should be dedicated to land uses which protect public health and are consistent with laws governing the environment.	ARAR since work will be completed within coastal area.
Wetlands	Federal National Environmental Policy Act (NEPA)	Statement of Procedures on Floodplain Management and Wetlands Protection	40 CFR 6, Appendix A	11990 - Protection of Wetlands. Wetlands are defined by Executive Order 11990, Section 7 are present at or adjacent to the site.	ARAR because wetlands are on site and are anticipated be affected by remediation.
Area Affecting Stream or River	Waterfront Development Upland Waterfront Permit	Statement of Procedures for work within waterfront	N.J.S.A. 12:5-3	Establishes the need for permitting when constructing or developing in coastal area between mean high tide.	ARAR because work will be completed within buffer zone of Berry's Creek.
Area Affecting Stream or River	Federal Clean Water Act	Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredge or Fill Material; Section 404 (c) Procedures; 404 Program Definitions; 404 State Program Regulations	40 CFR 230-233	Restricts discharge of dredged or fill material to wetlands or waters of the United States. Provides permitting program for situations with no other practical alternative.	ARAR because wetlands are on site and are anticipated be affected by remediation.
Wetlands	Wetlands Permit	Statement of Procedures for work in wetlands	N.J.S.A. 13:9A-1	Restricts work type and mitigative measures necessary within a wetlands.	ARAR since work will be completed within a wetland.

Appendix A
Potential Location-Specific ARARs

Area Affecting Stream or River	Federal Endangered and Non-Game Species Act	Protection of threatened and endangered species	N.J.S.A. 23:2A-1	Standards for the protection of threatened and endangered species.	Not an ARAR because no listed species have been identified at the site.
Area Affecting Stream or River	State Flood Control Facilities Act	Statement of Procedures for construction, operation, planning, or acquiring flood control facilities.	N.J.S.A. 58:16A-50 et seq.; N.J.A.C. 7:8-3.15	Standards to construct, operate, or acquire a flood control device.	Potential ARAR since changes in current runoff control may impact current flood control system on Berry's Creek.
Area Affecting Stream or River	Federal Endangered Species Act	Protection of threatened and endangered species	16 USC 1531 et seq.; 40 CFR 400	Standards for the protection of threatened and endangered species.	TBC because species could be present where suitable habitat exists.
Area Affecting Stream or River	Federal Fish and Wildlife Conservation Act	Statement of Procedures for Non-game Fish and Wildlife Protection	16 USC 2901 et seq.	Establishes EPA policy and guidance for promoting the conservation of non-game fish and wildlife and their habitats. Action must protect fish or wildlife.	Not an ARAR because no listed species have been identified at the site.
Wetlands	New Jersey Meadowlands Commission - Zoning Certificate	Procedures for work within the Meadowlands	N.J.S.A. 13:17-1 et seq.	Establishes New Jersey policy for all work within Meadowlands.	ARAR since work will be completed within New Jersey Meadowlands.
	Federal National Historic Preservation Act	Procedures for preservation of historical and archaeological data	16 USC 469 et seq.; 40 CFR 6301(c)	Establishes procedures to provide for preservation of historical and archaeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program.	No buildings of historic significance present onsite. No known archeological sites present.

Appendix B

Summary of Residential and Non-Residential Criteria Exceedances

Exponent®

E X T E R N A L   M E M O R A N D U M

TO: Ken Walanski

FROM: Betsy Henry

DATE: September 30, 2005

PROJECT: 8600B3N.005

SUBJECT: Ventron/Velsicol - Locations of Stations SS-67 through SS-74

We have reviewed the field notes, property maps, indentures, and aerial photos to determine the properties on which Stations SS-67 through SS-74 from the Ventron/Velsicol OU1 remedial investigation (RI) are located. These surface soil stations are located north of Ethel Boulevard at the northern boundary of the site, consistent with the original work plan developed by CRA. This memo describes the analysis and conclusions, as well as the locations and data for all off-site stations located north of Ethel Boulevard that exceed New Jersey soil cleanup criteria for site-related contaminants (i.e., mercury and lead).

Review of Field Notes

Exponent field staff collected soil samples from Stations SS-67 through SS-71 on May 6, 1998 and from Stations SS-72 through SS-74 on May 7, 1998, as part of the Phase I off-site surface soil investigation. These locations were surveyed after sampling. Samples were collected from depths of 0 to 6 in. with the exception of Station SS-67. At this station, the top 6 in. consisted of asphalt, rock, and gravel and, therefore, the sample was collected in the 6- to 12–in. interval. The presence of rock and gravel was not noted in the other samples.

Review of Property Maps and Indentures

Property maps and indentures we reviewed including the following:

- June 1973 Tax Map – Borough of Wood-Ridge
- March 1962 map included with the April 26, 1962 indenture from Bonnano *et ux* to the New Jersey and New York Railroad Company, for construction of a railroad spur (see Item 18 in Attachment A to Volume 4 of the RI report)

- April 11, 1962 indenture from the Borough of Wood-Ridge to the New Jersey and New York Railroad Company for construction of a spur along what is now called the former POTW property.

Web-based Geographic Information System (GIS) maps available from Bergen County were also reviewed; however, property lines depicted on these maps do not match features visible in the aerial photo that forms the base for these maps and therefore the property lines were not considered reliable.

According to the 1962 indentures, the railroad property is 20 ft wide for most of its length, with a small straight section adjacent to the Blum property and the section adjacent to the former POTW property being 21 ft wide. This is less than half the normal width of a railroad right-of-way (i.e., 50 ft), probably because the tracks in this case are a spur. Other than the width and general location of the railroad property, the maps and indentures did not provide specific information that could be used to locate property lines in a GIS-based analysis.

Determination of Station Locations

To determine station locations, the surveyed coordinates for the surface soil and borehole stations were first placed on an aerial photo of the property obtained from USGS. Surface soil station locations are identified in Figure 1 by a small orange dot surrounded by a 20-ft-diameter circle for ease of visualizing the station location. Borehole stations are identified in Figure 1 in the same manner, except in green. The centerline of the railroad tracks, which are visible in the aerial photo, was drawn on the figure in black and was assumed to be located in the center of the railroad property. Railroad property lines were then drawn on the figure in pink, based on the 20- and 21-ft-wide designations described in the property maps and indentures. Other property lines were also added based on review of property maps and indentures. [Note: Figure 1 is best viewed electronically at full size or printed out on 11×17 in. paper. The symbols and property lines are purposely small and thin to allow determination of location.

Based on this analysis, which assumes that the centerline of the tracks is the centerline of the railroad property, Station SS-67 is on EJB property, Stations SS-68, SS-70 and SS-71 are on railroad property, Station SS-69 is on Julius Blum & Company (Blum) property, and Stations SS-72 through SS-74 are on the former POTW property. Station SS-74 is not included in Figure 1 because no site-related criteria were exceeded at that location.

This analysis is somewhat uncertain because the actual location of the railroad property lines is unknown. However, the property lines are unlikely to differ from this analysis by more than a few feet because of the physical constraints of the site (i.e., railroad tracks, Ethel Boulevard, Blum building). If the railroad property lines were adjusted toward Ethel Boulevard (e.g., assuming that the curb marks the railroad property line), Stations SS-70 and SS-71 would be on the railroad/Prince Packing Products (Prince) property line and all other stations would be on the same properties as previously determined.

Summary of Site-Related Residential and Non-Residential Criteria Exceedances

The following table summarizes the location of all off-site (i.e., north of Ethel Boulevard) surface soil and borehole sampling stations with mercury or lead concentrations that exceed New Jersey non-residential direct contact soil cleanup criteria (NRDCSCC) and/or residential direct contact soil cleanup criteria (RDCSCC). These data also appear on Figure 1. While there were numerous criteria exceedances for polycyclic aromatic hydrocarbon (PAH) compounds, the Ventron/Velsicol OU1 RI report concluded that "the offsite soil PAHs in the area north of Ethel Boulevard are, therefore, not likely to be related to the Site" (Exponent 2004, Ventron/Velsicol OU1 RI report, page 5-25). No criteria were exceeded for other contaminants.

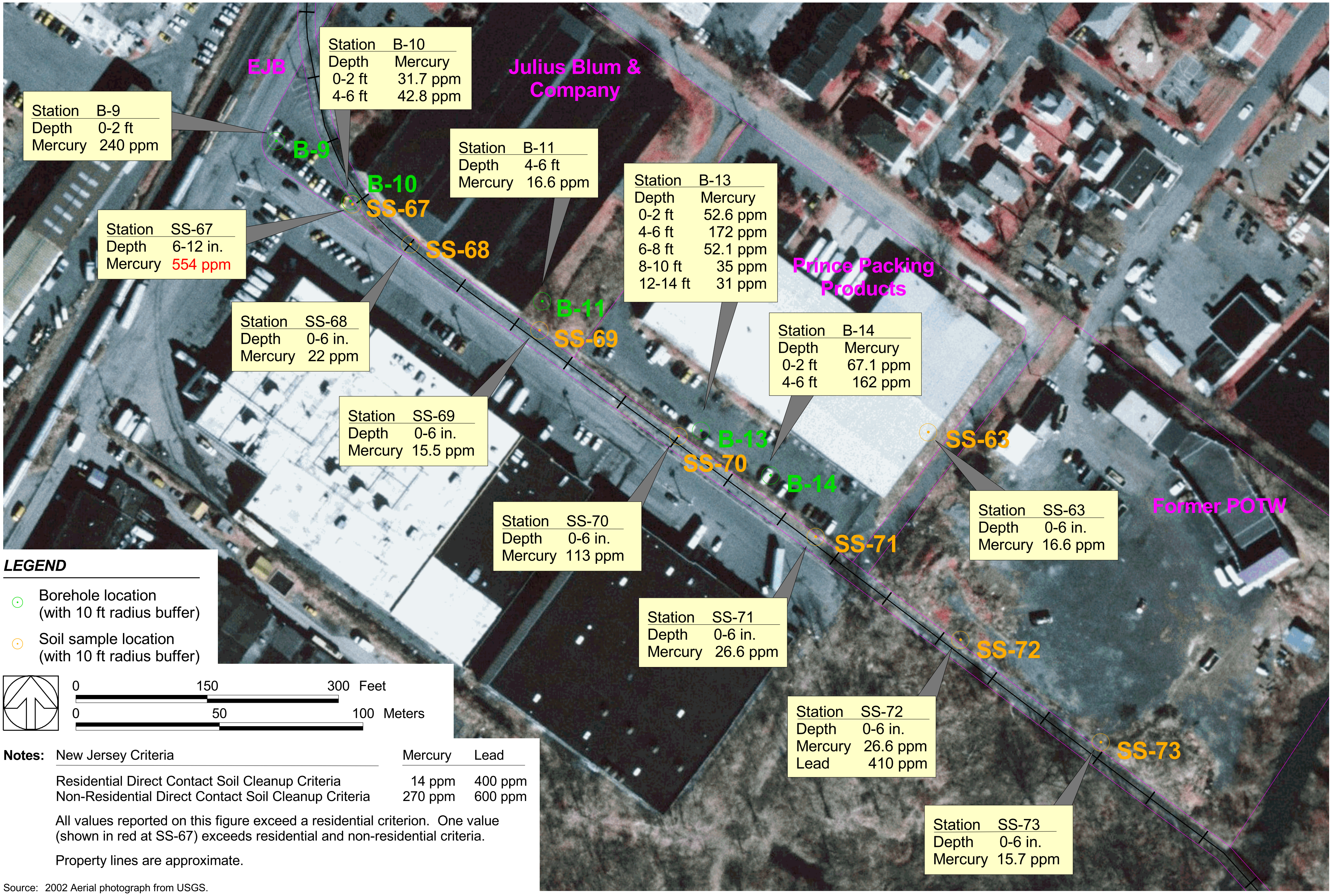
Property	Station	Depth Interval	Concentrations That Exceed RDCSCC [a] (ppm)		Concentrations That Exceed NRDCSCC[b] (ppm)	
			Mercury	Lead	Mercury	Lead
EJB	SS-67	6-12 in.	554	—[c]	554	—
	B-9	0-2 ft	240	na[d]	—	Na
	B-10	0-2 ft	31.7	na	—	Na
		4-6 ft	42.8	na	—	Na
Blum	B-11	4-6 ft	16.6	na	—	Na
	SS-69	0-6 in.	15.5	—	—	—
Railroad	SS-68	0-6 in.	22	—	—	—
	SS-70	0-6 in.	113	—	—	—
	SS-71	0-6 in.	26.6	—	—	—
Prince	B-13	0-2 ft	52.6	na	—	Na
		4-6 ft	172	na	—	Na
		6-8 ft	52.1	na	—	Na
		8-10 ft	35	na	—	Na
		12-14 ft	31	na	—	Na
	B-14	0-2 ft	67.1	na	—	Na
		4-6 ft	162	na	—	Na
	SS-63	0-6 in.	16.6	—	—	—
Former POTW	SS-72	0-6 in.	26	410	—	—
	SS-73	0-6 in.	15.7	—	—	—

Notes: (a) The RDCSCC are 14 ppm for mercury and 400 ppm for lead.

(b) The NRDCSCC are 270 ppm for mercury and 600 ppm for lead.

(c) The "—" symbol signifies no exceedance.

(d) The "na" notation signifies "not analyzed." Borehole samples were analyzed for mercury only.



Notes:

New Jersey Criteria	Mercury	Lead
Residential Direct Contact Soil Cleanup Criteria	14 ppm	400 ppm
Non-Residential Direct Contact Soil Cleanup Criteria	270 ppm	600 ppm

All values reported on this figure exceed a residential criterion. One value (shown in red at SS-67) exceeds residential and non-residential criteria.

Property lines are approximate.

Source: 2002 Aerial photograph from USGS.

Figure 1. Off-site stations with site-related exceedences of New Jersey criteria

Exponent®

October 7, 2005

8600B3N.005 | September 30,2005 | edited topo view | edited aerial layout | L:\Woodridge\Projects\soil_stations.apr

Appendix C
Detailed Cost Tables

Soil Media Alternatives Costs

COMPARISON OF TOTAL COST - SOIL REMEDIAL ALTERNATIVES

Site: Ventron/Velsicol Site - Wood-Ridge, New Jersey
Location: Soil Media
Phase: Feasibility Study

Base Year: 2005
Date: Rev 05/31/2006

	Soil Alternative S1 No Further Action	**Soil Alternative S2** Use Restrictions for Properties with Deed Notice Concurrence and Limited Excavation to RDCSCC	**Soil Alternative S3** Excavation of Undeveloped Area with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC	**Soil Alternative S4** Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC	**Soil Alternative S5** Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Excavation of Other Properties to RDCSCC, and Use Restrictions on Undeveloped and Developed Areas	**Soil Alternative S6** Excavation of Developed Area with ≥ 620 mg/kg Mercury, Excavation of Undeveloped Area and Other Properties to RDCSCC, and Use Restrictions on Developed Area	**Soil Alternative S7** Excavation of Undeveloped, Developed, and Other Properties to RDCSCC and Use Restrictions on the Railroad
Total Project Duration (Years)	50	50	50	50	50	50	0
Capital Cost	$0	$5,610,000	$7,930,000	$13,550,000	$14,140,000	$112,580,000	$135,300,000
Annual O&M Cost	$0	$29,900	$29,900	$31,000	$30,600	$5,500	$0
Total Periodic Cost	$150,000	$480,000	$480,000	$490,000	$490,000	$330,000	$0
Total Present Value of Alternative	$36,000	$6,130,000	$8,450,000	$14,090,000	$14,670,000	$112,750,000	$135,300,000

Disclaimer: The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternatives. This is an order-of-magnitude cost estimate that is expected to be within +50 to -30 percent of the actual project costs.

Alternative: **Soil Alternative S1** — **COST ESTIMATE SUMMARY**
Name: **No Further Action**

Site: Ventron/Velsicol Site - Wood-Ridge, New Jersey
Location: Soil Media
Phase: Feasibility Study
Base Year: 2005
Date: Rev 04/06/2006

Description: No additional actions undertaken other than the required 5 year reviews.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
No construction				$0	
TOTAL CAPITAL COST				**$0**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	LS	$5,000	$0	
TOTAL ANNUAL O&M COST				**$0**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
				Total	$150,000	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$0	$0	1.000	$0	
ANNUAL O&M COST	1 to 50	$0	$0	13.80	$0	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$15,000	$15,000	0.51	$7,625	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$15,000	$15,000	0.26	$3,876	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
PERIODIC COST	30	$15,000	$15,000	0.13	$1,971	
PERIODIC COST	35	$15,000	$15,000	0.09	$1,405	
PERIODIC COST	40	$15,000	$15,000	0.07	$1,002	
PERIODIC COST	45	$15,000	$15,000	0.05	$714	
PERIODIC COST	50	$15,000	$15,000	0.03	$509	
		$150,000			$35,997	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$36,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: Soil Alternative S2 — **COST ESTIMATE SUMMARY**

Name: Use Restrictions for Properties with Deed Notice Concurrence and Limited Excavation to RDCSCC

Site: Ventron/Velsicol Site - Wood-Ridge, New Jersey
Location: Soil Media
Phase: Feasibility Study
Base Year: 2005
Date: Rev 04/06/2006

Description: Installation of asphalt cap in undeveloped fill area and EJB Property, along with upgrades of existing cap in developed area. Cap consists of 4-inch asphalt cover with 6 inches of gravel sub-base. Removal of soil in the 55-foot buffer area for placement under cap. Limited removal of sediment, disposal at nonhazardous landfill, and lining of west ditch adjacent to wetlands. Blum, Prince Packing, and RR properties will have institutional controls only. Excavation of Lin-Mor to RDCSCC.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Site Establishment					
Support Area Establishment and Site Offices	4	MO	$6,623	26,492	Source 4
SUBTOTAL				26,492	
Mobilization/Demobilization	5%			1,325	Source 3
Subcontractor General Conditions	15%			3,974	Source 3
SUBTOTAL				31,791	
Institutional Controls	8	LS	$25,000	200,000	Source 3
(EJB, U.S. Life, Wolf, Blum, Prince Packing, Borough of Wood-Ridge, Railroad, Undeveloped Fill Area)					
Asphalt Cap Area (Undeveloped Fill Area)					
Silt Fencing	3,500	FT	$3.36	$11,750	MEANS 18 05 0206
Clear and Grub	15.6	AC	$8,065.61	$126,206	MEANS 17 01 0106
Rough Grading	75,733	SY	$5.15	$389,693	MEANS 17 03 0101
Fine Grading	75,733	SY	$1.42	$107,669	MEANS 17 03 0103
Gravel Base, 6 inches	12,622	CY	$34.55	$436,095	MEANS 18-01-0102
Asphalt stabilized base course 2" thick	4,207	CY	$47.74	$200,842	MEANS 18-01-0105
Asphalt wearing course 2" thick	6,311	TN	$86.87	$548,257	MEANS 18-02-0312
Install asphalt curb/berm	2,400	FT	$4.20	$10,080	Source 3
SUBTOTAL				$1,830,591	
Mobilization/Demobilization	5%			$91,530	Source 3
Subcontractor General Conditions	15%			$274,589	Source 3
SUBTOTAL				$2,196,709	
Asphalt Cap Area (Developed Area and EJB Property)					
Rough Grading - EJB Property	1,162	SY	$5.15	$5,977	MEANS 17 03 0101
Fine Grading - EJB Property	1,162	SY	$1.42	$1,651	MEANS 17 03 0103
Gravel Base, 6 inches - EJB Property	194	CY	$34.55	$6,689	MEANS 18-01-0102 + Source 3
Asphalt stabilized base course 2" thick - EJB Property	65	CY	$47.74	$3,081	MEANS 18-01-0105
Asphalt wearing course 2" thick - EJB Property	97	TN	$86.87	$8,409	MEANS 18-02-0312
Limited Regrading (2"Asphalt over 10% of remaining Area)	141	TN	$86.87	$12,265	MEANS 18-01-0105 - Assumed 10% of SY Area for seal coat
2 Coat seal coating	16,943	SY	$1.07	$18,129	Source 3
Installation of Asphalt Berm	690	FT	$4.20	$2,898	Source 3
SUBTOTAL				$59,099	
Mobilization/Demobilization	5%			$2,955	Source 3
Subcontractor General Conditions	15%			$8,865	Source 3
SUBTOTAL				$70,919	
Excavation (Lin-Mor Property)					
AC Demolition	1,000	SY	$3.76	$3,760	Source 3
Excavation & loading of soil > RDCSCC to 2 ft bgs	700	CY	$5.54	$3,879	MEANS 17-03-0276
Cart excavated soil to undeveloped fill area	700	CY	$4.28	$2,999	Source 4, Assume 1 Day (2 Trucks)
Compact excavated soil in undeveloped fill area	700	CY	$5.69	$3,985	MEANS 17-03-0415
Clean backfill/place/compact excavated area (lower 14 inches)	467	CY	$12.42	$5,795	MEANS 17-03-0423 (1.2 compaction factor)
Gravel base, 6 inches	167	CY	$34.55	$5,758	MEANS 18-01-0102 + Source 3
Asphalt-stabilized base course, 2 inches	56	CY	$47.74	$2,652	MEANS 18-01-0105
Asphalt-wearing course, 2 inches	83	TN	$86.87	$7,239	MEANS 18-02-0312
SUBTOTAL				$36,068	
Mobilization/Demobilization	5%			$1,803	Source 3
Subcontractor General Conditions	15%			$5,410	Source 3
SUBTOTAL				$43,282	
Excavation (Drain Line)					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Source 3
Locate Drain Line & Excavate	1	LS	$11,312.45	$11,312	Source 4
Cut and dispose of drain line	778	LF	$7.28	$5,662	Source 4
SUBTOTAL				$26,975	
Mobilization/Demobilization	5%			$1,349	Source 3
Subcontractor General Conditions	15%			$4,046	Source 3
SUBTOTAL				$32,370	
Excavation of West Ditch					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Source 3
Silt Fencing - Ditch Area	1,200	FT	$3.36	$4,028	MEANS 18 05 0206
Coffer Dam and bypass piping	1.0	LS	$80,000.00	$80,000	Panther
Excavate and Load	450	CY	$5.54	$2,494	MEANS 17-03-0276
Grade, place geofabric	12,000	SF	$2.00	$24,000	Source 3
Geomembrane Liner	12,000	SF	$3.50	$42,000	Source 3
Clean Backfill/Place/Compact	540	CY	$12.42	$6,705	MEANS 17-03-0423 (1.2 compaction factor)
Supply and Installation of Vegetation	0.28	AC	$47,601.84	$13,113	Source 4
SUBTOTAL				$182,341	
Mobilization/Demobilization	5%			$9,117	Source 3
Subcontractor General Conditions	15%			$27,351	Source 3
SUBTOTAL				$218,809	
Removal of 55' Buffer					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Source 3
Silt Fencing - Wetland Area	2,400	FT	$3.36	$8,057	MEANS 18 05 0206
Clear and Grub	3.4	AC	$8,065.61	$27,774	MEANS 17-01-0106
Install stormwater control measures	3	EA	$7,489.93	$22,470	Source 4
Install temp stormwater diversion	1	LS	$1,103.85	$1,104	Source 4
Setup Temp SP area - bunded and lined HDPE	1	LS	$3,622.00	$3,622	Source 4
Soil Excavation and Truck Loading	22,400	CY	$5.54	$124,123	MEANS 17-03-0276
Clean Backfill/Place/Compact/Topsoil/Reseed	1	LS	$457,345.13	$457,345	Source 4
SUBTOTAL				$654,495	
Mobilization/Demobilization	5%			$32,725	Source 3
Subcontractor General Conditions	15%			$98,174	Source 3
SUBTOTAL				$785,394	

Alternative: **Soil Alternative S2** **COST ESTIMATE SUMMARY**

Name: **Use Restrictions for Properties with Deed Notice Concurrence and Limited Excavation to RDCSCC**

Compliance Monitoring and Health & Safety					
Environmental Controls	1	LS	$5,396.60	$5,397	Source 4
Analytical Requirements	1	LS	$61,230.00	$61,230	Source 3, Assume $2.60 per CY Excavated
Install Decon Shed for workers (Mobilization & Demobilization)	1	LS	$500.00	$500	Source 3
Decon Shed	2	MO	$1,042.53	$2,085	Source 4
Air Monitoring	34	DY	$717.50	$24,395	Source 4 + CH2M H&S
PPE Provisions for Workers (Initial)	8	EA	$300.95	$2,408	Source 4
PPE Provisions for Workers (Worker-Days)	251	EA	$31.86	$7,998	Source 4 + CH2M H&S
SUBTOTAL				$104,012	
Mobilization/Demobilization	5%			$5,201	Source 3
Subcontractor General Conditions	15%			$15,602	Source 3
SUBTOTAL				$124,815	
Subtitle D Landfill Transport and Disposal					
Permits, Submittals & Workplans	1	LS	$ 10,000	$10,000	Includes submittals
Subtiltle D Transport & Landfill Disposal	675	TN	$ 68.00	$45,900	EWMI Quote
SUBTOTAL				$55,900	
Mobilization/Demobilization	5%			$2,795	Source 3
Subcontractor General Conditions	15%			$8,385	Source 3
SUBTOTAL				$67,080	
SUBTOTAL				$3,771,168	
Contingency	25%			$942,792	10% Scope + 15% Bid
SUBTOTAL				$4,713,960	
Project Management	5%			$235,698.00	**USEPA 2000, p. 5-13, $2M-$10M**
Remedial Design	8%			$377,116.80	**USEPA 2000, p. 5-13, $2M-$10M**
Construction Management	6%			$282,837.60	**USEPA 2000, p. 5-13, $2M-$10M**
SUBTOTAL				$895,652.41	
TOTAL CAPITAL COST				**$5,610,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Cap Semi-Annual Inspection	8	Hr	$80.00	$640	
Cap Repair	1.0	LS	$17,387.57	$17,388	Assumes 1% of area requires repair annually
Cap Inspection and Repair Report	1.0	LS	$2,000.00	$2,000	Biennial Report to NJDEP
SUBTOTAL				$20,028	
Contingency	30%			$6,008	10% Scope + 20% Bid
SUBTOTAL				$26,036	
Project Management	5%			$1,302	
Technical Support	10%			$2,604	
TOTAL ANNUAL O&M COST				**$29,900**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
Air Monitoring Field Sampling Plan and Sampling Event	1	1	LS	$6,200.00	$6,200	CH2M HILL Estimate, Source 5
Air Monitoring Biennial Sampling Event	3	1	LS	$3,200.00	$3,200	CH2M HILL Estimate, Source 5
Air Monitoring Biennial Sampling Event	5	1	LS	$3,200.00	$3,200	CH2M HILL Estimate, Source 5
2 Year Biennial Certification	2	1	LS	$4,122.61	$4,123	Source 4
2 Year Biennial Certification	4	1	LS	$4,122.61	$4,123	Source 4
5 year Review	5	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	6	1	LS	$4,122.61	$4,123	Source 4
Air Monitoring Biennial Sampling Event	6	1	LS	$3,200.00	$3,200	CH2M HILL Estimate, Source 5
2 Year Biennial Certification	8	1	LS	$4,122.61	$4,123	Source 4
Air Monitoring Biennial Sampling Event	8	1	LS	$3,200.00	$3,200	CH2M HILL Estimate, Source 5
5 year Review	10	1	LS	$19,122.61	$19,123	Source 4
Air Monitoring Biennial Sampling Event	10	1	LS	$3,200.00	$3,200	CH2M HILL Estimate, Source 5
2 Year Biennial Certification	12	1	LS	$4,122.61	$4,123	Source 4
Air Monitoring Biennial Sampling Event	12	1	LS	$3,200.00	$3,200	CH2M HILL Estimate, Source 5
2 Year Biennial Certification	14	1	LS	$4,122.61	$4,123	Source 4
Air Monitoring Biennial Sampling Event	14	1	LS	$3,200.00	$3,200	CH2M HILL Estimate, Source 5
5 year Review	15	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	16	1	LS	$4,122.61	$4,123	Source 4
Air Monitoring Biennial Sampling Event	16	1	LS	$3,200.00	$3,200	CH2M HILL Estimate, Source 5
2 Year Biennial Certification	18	1	LS	$4,122.61	$4,123	Source 4
Air Monitoring Biennial Sampling Event	18	1	LS	$3,200.00	$3,200	CH2M HILL Estimate, Source 5
5 year Review	20	1	LS	$19,122.61	$19,123	Source 4
Air Monitoring Biennial Sampling Event	20	1	LS	$3,200.00	$3,200	CH2M HILL Estimate, Source 5
2 Year Biennial Certification	22	1	LS	$4,122.61	$4,123	Source 4
Air Monitoring Biennial Sampling Event	22	1	LS	$3,200.00	$3,200	CH2M HILL Estimate, Source 5
2 Year Biennial Certification	24	1	LS	$4,122.61	$4,123	Source 4
Air Monitoring Biennial Sampling Event	24	1	LS	$3,200.00	$3,200	CH2M HILL Estimate, Source 5
5 year Review	25	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	26	1	LS	$4,122.61	$4,123	Source 4
Air Monitoring Biennial Sampling Event	26	1	LS	$3,200.00	$3,200	CH2M HILL Estimate, Source 5
2 Year Biennial Certification	28	1	LS	$4,122.61	$4,123	Source 4
Air Monitoring Biennial Sampling Event	28	1	LS	$3,200.00	$3,200	CH2M HILL Estimate, Source 5
Asphalt Cap Replacement	30	1	LS	$192,717.91	$192,718	
Air Monitoring Biennial Sampling Event	30	1	LS	$3,200.00	$3,200	CH2M HILL Estimate, Source 5
2 Year Biennial Certification	32	1	LS	$4,122.61	$4,123	Source 4
2 Year Biennial Certification	34	1	LS	$4,122.61	$4,123	Source 4
5 year Review	35	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	36	1	LS	$4,122.61	$4,123	Source 4
2 Year Biennial Certification	38	1	LS	$4,122.61	$4,123	Source 4
5 year Review	40	1	LS	$19,122.61	$19,123	
2 Year Biennial Certification	42	1	LS	$4,122.61	$4,123	Source 4
2 Year Biennial Certification	44	1	LS	$4,122.61	$4,123	Source 4
5 year Review	45	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	46	1	LS	$4,122.61	$4,123	Source 4
2 Year Biennial Certification	48	1	LS	$4,122.61	$4,123	Source 4
5 year Review	50	1	LS	$19,122.61	$19,123	
				Total	$480,000	
TOTAL ANNUAL PERIODIC COST					**$480,000**	

Alternative: **Soil Alternative S2** **COST ESTIMATE SUMMARY**

Name: **Use Restrictions for Properties with Deed Notice Concurrence and Limited Excavation to RDCSCC**

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$5,610,000	$5,610,000	$1.00	$5,610,000	
ANNUAL O&M COST	1 to 50	$1,495,000	$29,900	$13.80	$412,642	
PERIODIC COST	1	$6,200	$6,200	$0.93	$5,794	
PERIODIC COST	2	$4,123	$4,123	$0.87	$3,601	
PERIODIC COST	3	$3,200	$3,200	$0.82	$2,612	
PERIODIC COST	4	$4,123	$4,123	$0.76	$3,145	
PERIODIC COST	5	$18,200	$18,200	$0.71	$12,976	
PERIODIC COST	6	$7,323	$7,323	$0.67	$4,879	
PERIODIC COST	8	$7,323	$7,323	$0.58	$4,262	
PERIODIC COST	10	$22,323	$22,323	$0.51	$11,348	
PERIODIC COST	12	$7,323	$7,323	$0.44	$3,251	
PERIODIC COST	14	$7,323	$7,323	$0.39	$2,840	
PERIODIC COST	15	$15,000	$15,000	$0.36	$5,437	
PERIODIC COST	16	$7,323	$7,323	$0.34	$2,480	
PERIODIC COST	18	$7,323	$7,323	$0.30	$2,166	
PERIODIC COST	20	$22,323	$22,323	$0.26	$5,769	
PERIODIC COST	22	$7,323	$7,323	$0.23	$1,653	
PERIODIC COST	24	$7,323	$7,323	$0.20	$1,444	
PERIODIC COST	25	$15,000	$15,000	$0.18	$2,764	
PERIODIC COST	26	$7,323	$7,323	$0.17	$1,261	
PERIODIC COST	28	$7,323	$7,323	$0.15	$1,101	
PERIODIC COST	30	$195,918	$195,918	$0.13	$25,737	
PERIODIC COST	32	$4,123	$4,123	$0.11	$473	
PERIODIC COST	34	$4,123	$4,123	$0.10	$413	
PERIODIC COST	35	$15,000	$15,000	$0.09	$1,405	
PERIODIC COST	36	$4,123	$4,123	$0.09	$361	
PERIODIC COST	38	$4,123	$4,123	$0.08	$315	
PERIODIC COST	40	$19,123	$19,123	$0.07	$1,277	
PERIODIC COST	42	$4,123	$4,123	$0.06	$240	
PERIODIC COST	44	$4,123	$4,123	$0.05	$210	
PERIODIC COST	45	$15,000	$15,000	$0.05	$714	
PERIODIC COST	46	$4,123	$4,123	$0.04	$183	
PERIODIC COST	48	$4,123	$4,123	$0.04	$160	
PERIODIC COST	50	$19,123	$19,123	$0.03	$649	
		$7,600,000			$6,133,565	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$6,130,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).
2. R.S. Means Company. 2004. Environmental Remediation Cost Data - Unit Price, 10th Edition. R.S. Means Company and Talisman Partners, Ltd. Kingston, MA.
3. Historical CH2M HILL project cost information and vendor quotes
4. Calculations using Historical CH2M HILL project cost information (separate worksheet)
5. Based on NIOSH Method 6009, 3 sampling stations, 2 samples/station, 1 field duplicate, 1 field blank

Alternative: **Soil Alternative S3** — **COST ESTIMATE SUMMARY**

Name: **Excavation of Undeveloped Area with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC**

Site: Ventron/Velsicol Site - Wood-Ridge, New Jersey
Location: Soil Media
Phase: Feasibility Study
Base Year: 2005
Date: Rev 05/31/2006

Description: Excavation of soil from the undeveloped fill area with mercury >620 ppm. Excavation of soil from the 55-foot buffer area for placement under the cap. Removal approximately 1 foot of sediment from the west ditch and disposal at nonhazardous waste landfill. Cap consists of 4-inch asphalt cover with 6 inches of gravel sub-base. Soil excavated from Lin-Mor property will be placed in undeveloped fill area for capping. Installation of asphalt cap in undeveloped fill area and EJB Property, along with upgrades of exisiting cap in developed area.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Site Establishment					
Support Area Establishment and Site Offices	5	MO	$6,623	$33,116	Source 4
SUBTOTAL				$33,116	
Mobilization/Demobilization	5%			$1,656	Source 3
Subcontractor General Conditions	15%			$4,967	Source 3
SUBTOTAL				$39,739	
Institutional Controls	8	LS	$25,000	$200,000	CH2M Est.
(Blum, Prince Packing, U.S. Life, Wolf, EJB, Railroad, Wood-Ridge, Undeveloped Area)					
SUBTOTAL				$200,000	
Asphalt Cap Area (Undeveloped Fill Area)					
Silt Fencing	3,500	FT	$3.36	$11,750	MEANS 18 05 0206
Clear and Grub	15.6	AC	$8,065.61	$126,206	MEANS 17 01 0106
Rough Grading	75,733	SY	$5.15	$389,693	MEANS 17 03 0101
Fine Grading	75,733	SY	$1.42	$107,669	MEANS 17 03 0103
Gravel Base, 6 inches	12,622	CY	$34.55	$436,095	MEANS 18-01-0102
Asphalt stabilized base course 2" thick	4,207	CY	$47.74	$200,842	MEANS 18-01-0105
Asphalt wearing course 2" thick	6,311	TN	$86.87	$548,257	MEANS 18-020312
Install Asphalt Curb/Berm on Perimeter	2400	FT	$4.20	$10,080	Source 3
SUBTOTAL				$1,830,591	
Mobilization/Demobilization	5%			$91,530	Source 3
Subcontractor General Conditions	15%			$274,589	Source 3
SUBTOTAL				$2,196,709	
Asphalt Cap Areas and Lin-Mor Excavation					
Lin-Mor					
AC Demolition	1,000	SY	$3.76	$3,760	CH2M Est.
Excavation & Loading of Soil > RDCSCC to 2 ft depth	700	CY	$5.54	$3,879	MEANS 17-03-0276
Cart excavated soils to undeveloped fill area	700	CY	$4.28	$2,999	Source 4, Assume 1 Day (2 Trucks)
Compact excavated soils in undeveloped fill area	700	CY	$5.69	$3,985	MEANS 17-03-0415
Clean Backfill/Place/Compact Excavated Area (Lower 14")	467	CY	$12.42	$5,795	1.2 Compaction Factor
Gravel Base, 6 inches	167	CY	$34.55	$5,758	
Asphalt stabilized base course 2" thick	56	CY	$47.74	$2,652	
Asphalt wearing course 2" thick	83	TN	$86.87	$7,239	
EJB					
Rough Grading	1,162	SY	$5.15	$5,977	MEANS 17 03 0101
Fine Grading	1,162	SY	$1.42	$1,651	MEANS 17 03 0103
Gravel Base, 6 inches	194	CY	$34.55	$6,689	MEANS 18-01-0102 + Source 3
Asphalt stabilized base course 2" thick	65	CY	$47.74	$3,081	MEANS 18-01-0105
Asphalt wearing course 2" thick	97	TN	$86.87	$8,409	MEANS 18-02-0312
Asphalt Repair - Developed Area					
Limited Regrading (2"Asphalt over 10% of Remaining Area)	141	TN	$86.87	$12,265	MEANS 18-02-0312
2 Coat Seal Coating	16,943	SY	$1.07	$18,129	Source 3
Installation of asphalt berm	690	FT	$4.20	$2,898	Source 3
SUBTOTAL				$95,167	
Mobilization/Demobilization	5%			$4,758	Source 3
Subcontractor General Conditions	15%			$14,275	Source 3
SUBTOTAL				$114,200	
Excavation (Drain Line)					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Source 3
Locate Drain Line	1	LS	$11,312.45	$11,312	Source 4
Cut and dispose of drain line	778	LF	$7.28	$5,662	Source 4
SUBTOTAL				$26,975	
Mobilization/Demobilization	5%			$1,349	Source 3
Subcontractor General Conditions	15%			$4,046	Source 3
SUBTOTAL				$32,370	
Excavation (Hg>620 mg/kg) - Undeveloped Area					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Includes submittals;
Soil Excavation and Truck Loading	2,100	CY	$5.54	$11,637	MEANS 17-03-0276
Clean Backfill/Place/Compact	2,520	CY	$12.42	$31,292	MEANS 17-03-0423 (1.2 Compaction Factor)
Install temp stormwater diversion	1	LS	$1,103.85	$1,104	Source 4
Setup Temp SP area - bunded and lined HDPE	1	LS	$3,622.00	$3,622	Source 4
SUBTOTAL				$57,654	
Mobilization/Demobilization	5%			$2,883	Source 3
Subcontractor General Conditions	15%			$8,648	Source 3
SUBTOTAL				$69,185	
Excavation of West Ditch					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Source 3
Silt Fencing - Ditch Area	1,200	FT	$3.36	$4,028	MEANS 18 05 0206
Coffer Dam and bypass piping	1.0	LS	$80,000.00	$80,000	Panther
Excavate and Load	450	CY	$5.54	$2,494	MEANS 17-03-0276
Grade, place geofabric	12,000	SF	$2.00	$24,000	Source 3
Geomembrane Liner	12,000	SF	$3.50	$42,000	Source 3
Clean Backfill/Place/Compact	540	CY	$12.42	$6,705	MEANS 17-03-0276
Supply and Installation of Vegetation	0.28	AC	$47,601.84	$13,113	Source 4

SUBTOTAL				$182,341	
Mobilization/Demobilization	5%			$9,117	Source 3
Subcontractor General Conditions	15%			$27,351	Source 3
SUBTOTAL				$218,809	
Removal of 55' Buffer					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Source 3
Silt Fencing - Wetland Area	2,400	FT	$3.36	$8,057	MEANS 18 05 0206
Clear and Grub	3.4	AC	$8,065.61	$27,774	MEANS 17-01-0106
Install stormwater control measures	3	EA	$7,489.93	$22,470	Source 4
Install temp stormwater diversion	1	LS	$1,103.85	$1,104	Source 4
Setup Temp SP area - bunded and lined HDPE	1	LS	$3,622.00	$3,622	Source 4
Soil Excavation and Truck Loading	22,400	CY	$5.54	$124,123	MEANS 17-03-0276
Clean Backfill/Place/Compact/Topsoil/Reseed	1	LS	$457,345.13	$457,345	Source 4
SUBTOTAL				$654,495	
Mobilization/Demobilization	5%			$32,725	Source 3
Subcontractor General Conditions	15%			$98,174	Source 3
SUBTOTAL				$785,394	
Compliance Monitoring and Health & Safety					
Environmental Controls	1	LS	$5,396.60	$5,397	Source 4
Analytical Requirements	1	LS	$66,690.00	$66,690	Source 3, Assume $2.60 per CY Excavated
Install Decon Shed for workers (Mobilization & Demobilization)	1	LS	$500.00	$500	Source 3
Decon Shed	2	MO	$1,042.53	$2,085	Source 4
Air Monitoring	39	DY	$717.50	$27,983	Source 4 + CH2M H&S
PPE Provisions for Workers (Initial)	8	EA	$300.95	$2,408	Source 4
PPE Provisions for Workers (Worker·Days)	286	EA	$31.86	$9,113	Source 4 + CH2M H&S
SUBTOTAL				$114,175	
Mobilization/Demobilization	5%			$5,709	Source 3
Subcontractor General Conditions	15%			$17,126	Source 3
SUBTOTAL				$137,010	
Subtitle D Landfill Transport and Disposal					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Includes submittals
Subtiltle D Transport & Landfill Disposal	675	TN	$68.00	$45,900	EWMI Quote
SUBTOTAL				$55,900	
Mobilization/Demobilization	5%			$2,795	Source 3
Subcontractor General Conditions	15%			$8,385	Source 3
SUBTOTAL				$67,080	
Treatment/Disposal of Hg-impacted Soil					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Includes submittals
Treatability Evaluation/Design	1	LS	$40,000.00	$40,000	Quote from Hazen
Load Material for Transport to Landfill	2,100	CY	$5.54	$11,637	MEANS 17-03-0276
Transport to Hazardous Waste Facility (Emelle, AL)	3,150	TN	$70.00	$220,500	Waste Management Quote, shipment by rail
Stabilization and Disposal of Hg-hazardous Soil	3,150	TN	$300.00	$945,000	Waste Mangement Quote
SUBTOTAL				$1,227,137	
Mobilization/Demobilization	5%			$61,357	Source 3
Subcontractor General Conditions	15%			$184,070	Source 3
SUBTOTAL				$1,472,564	
SUBTOTAL				$5,333,060	
Contingency	25%			$1,333,265	10% Scope + 15% Bid
SUBTOTAL				$6,666,325	
Project Management	5%			$333,316	**USEPA 2000, p. 5-13, $2M - $10M**
Remedial Design	8%			$533,306	**USEPA 2000, p. 5-13, $2M - $10M**
Construction Management	6%			$399,980	**USEPA 2000, p. 5-13, $2M - $10M**
SUBTOTAL				$1,266,602	
TOTAL CAPITAL COST				**$7,930,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Cap O&M					Year 1 to 50
Cap Semi-annual Inspection	8	Hr	$80.00	$640	
Cap Repair	1.0	LS	$17,326.57	$17,327	Assumes 1% of area requires repair annually
Cap Inspection and Repair Report	1.0	LS	$2,000.00	$2,000	Biennial Report to NJDEP
SUBTOTAL				$19,967	
Contingency	30%			$5,990	10% Scope + 20% Bid
SUBTOTAL				$25,957	
Project Management	5%			$1,298	
Technical Support	10%			$2,596	
TOTAL ANNUAL O&M COST				**$29,900**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
Air Monitoring Sampling Plan and Sampling Event	1	1	LS	$6,200.00	$6,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	2	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampoling Event	3	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	4	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampoling Event	5	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
5 year Review	5	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	6	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	6	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	8	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	8	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
5 year Review	10	1	LS	$19,122.61	$19,123	
Air Monitoring Biennial Sampling Event	10	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	12	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet

Alternative: **Soil Alternative S3** **COST ESTIMATE SUMMARY**

Name: **Excavation of Undeveloped Area with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC**

Air Monitoring Biennial Sampling Event	12	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	14	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	14	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
5 year Review	15	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	16	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	16	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	18	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	18	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
5 year Review	20	1	LS	$19,122.61	$19,123	
Air Monitoring Biennial Sampling Event	20	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	22	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	22	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	24	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	24	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
5 year Review	25	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	26	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	26	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	28	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	28	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
Asphalt Cap Replacement	30	1	LS	$193,410.86	$193,411	Assume 30% of 4" cap replaced
Air Monitoring Biennial Sampling Event	30	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	32	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	34	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	35	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	36	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	38	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	40	1	LS	$19,122.61	$19,123	
2 Year Biennial Certification	42	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	44	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	45	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	46	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	48	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	50	1	LS	$19,122.61	$19,123	
				Total	$480,000	

TOTAL ANNUAL PERIODIC COST **$480,000**

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$7,930,000	$7,930,000	$1.00	$7,930,000	
ANNUAL O&M COST - Cap	1 to 50	$1,495,000	$29,900	$13.80	$412,642	
PERIODIC COST	1	$6,200	$6,200	$0.93	$5,794	
PERIODIC COST	2	$4,123	$4,123	$0.87	$3,601	
PERIODIC COST	3	$3,200	$3,200	$0.82	$2,612	
PERIODIC COST	4	$4,123	$4,123	$0.76	$3,145	
PERIODIC COST	5	$18,200	$18,200	$0.71	$12,976	
PERIODIC COST	6	$7,323	$7,323	$0.67	$4,879	
PERIODIC COST	8	$7,323	$7,323	$0.58	$4,262	
PERIODIC COST	10	$22,323	$22,323	$0.51	$11,348	
PERIODIC COST	12	$7,323	$7,323	$0.44	$3,251	
PERIODIC COST	14	$7,323	$7,323	$0.39	$2,840	
PERIODIC COST	15	$15,000	$15,000	$0.36	$5,437	
PERIODIC COST	16	$7,323	$7,323	$0.34	$2,480	
PERIODIC COST	18	$7,323	$7,323	$0.30	$2,166	
PERIODIC COST	20	$22,323	$22,323	$0.26	$5,769	
PERIODIC COST	22	$7,323	$7,323	$0.23	$1,653	
PERIODIC COST	24	$7,323	$7,323	$0.20	$1,444	
PERIODIC COST	25	$15,000	$15,000	$0.18	$2,764	
PERIODIC COST	26	$7,323	$7,323	$0.17	$1,261	
PERIODIC COST	28	$7,323	$7,323	$0.15	$1,101	
PERIODIC COST	30	$196,611	$196,611	$0.13	$25,828	
PERIODIC COST	32	$4,123	$4,123	$0.11	$473	
PERIODIC COST	34	$4,123	$4,123	$0.10	$413	
PERIODIC COST	35	$15,000	$15,000	$0.09	$1,405	
PERIODIC COST	36	$4,123	$4,123	$0.09	$361	
PERIODIC COST	38	$4,123	$4,123	$0.08	$315	
PERIODIC COST	40	$19,123	$19,123	$0.07	$1,277	
PERIODIC COST	42	$4,123	$4,123	$0.06	$240	
PERIODIC COST	44	$4,123	$4,123	$0.05	$210	
PERIODIC COST	45	$15,000	$15,000	$0.05	$714	
PERIODIC COST	46	$4,123	$4,123	$0.04	$183	
PERIODIC COST	48	$4,123	$4,123	$0.04	$160	
PERIODIC COST	50	$19,123	$19,123	$0.03	$649	
					$8,453,656	

TOTAL PRESENT VALUE OF ALTERNATIVE **$8,450,000**

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).
2. R.S. Means Company. 2004. Environmental Remediation Cost Data - Unit Price, 10th Edition. R.S. Means Company and Talisman Partners, Ltd. Kingston, MA.
3. Historical CH2M HILL project cost information
4. Calculations using Historical CH2M HILL project cost information (separate worksheet)

Alternative: **Soil Alternative S4** **COST ESTIMATE SUMMARY**

Name: **Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC**

Site: Ventron/Velsicol Site - Wood-Ridge, New Jersey
Location: Soil Media
Phase: Feasibility Study
Base Year: 2005
Date: Rev 05/31/2006

Description: Excavation of soil from the undeveloped fill area and developed area adjacent to Warehouses.
Excavation of soil from the 55-foot buffer area with placement below the cap.
Soil excavated from Lin-Mor property to be placed in undeveloped fill area for capping.
Removal approximaely 1 foot of sediment from the west ditch and disposal at a nonhazardous waste landfill.
Treatment and off site disposal of Hg-hazardous soil ≥ 620 mg/kg.
Installation of asphalt cap in undeveloped fill area and EJB Property, along with upgrades of existing cap in developed area w/ repairs in excavated areas. Cap consists of 4-inch asphalt cover with 6 inches of gravel sub-base.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Site Establishment					
Support Area Establishment and Site Offices	6	MO	$6,623	$39,739	Source 4
SUBTOTAL				$39,739	
Mobilization/Demobilization	5%			$1,987	Source 3
Subcontractor General Conditions	15%			$5,961	Source 3
SUBTOTAL				$47,686	
Institutional Controls	8	LS	$25,000	$200,000	Source 3
(Blum, Prince Packing, U.S. Life, Wolf, EJB, Railroad, Wood-Ridge, Undeveloped Area)					
SUBTOTAL				$200,000	
Asphalt Cap Area (Undeveloped Fill Area)					
Silt Fencing	3,500	FT	$3.36	$11,750	MEANS 18 05 0206
Clear and Grub	15.6	AC	$8,065.61	$126,206	MEANS 17 01 0106
Rough Grading	75,733	SY	$5.15	$389,693	MEANS 17 03 0101
Fine Grading	75,733	SY	$1.42	$107,669	MEANS 17 03 0103
Gravel Base, 6 inches	12,622	CY	$34.55	$436,095	MEANS 18-01-0102
Asphalt stabilized base course 2" thick	4,207	CY	$47.74	$200,842	MEANS 18-01-0105
Asphalt wearing course 2" thick	6,311	TN	$86.87	$548,257	MEANS 18-02-0312
Install asphalt Berm around perimeter of undeveloped area	2400	FT	$4.20	$10,080	Source 3
SUBTOTAL				$1,830,591	
Mobilization/Demobilization	5%			$91,530	Source 3
Subcontractor General Conditions	15%			$274,589	Source 3
SUBTOTAL				$2,196,709	
Asphalt Cap Area (Developed Area and Off Site Properties)					
Lin-Mor					
AC Demolition	1,000	SY	$3.76	$3,760	CH2M Est.
Excavation & Loading of Soil > RDCSCC to 2 ft depth	700	CY	$5.54	$3,879	MEANS 17-03-0276
Cart excavated soils to undeveloped fill area	700	CY	$4.28	$2,999	Source 4, Assume 1 Day (2
Compact excavated soils in undeveloped fill area	700	CY	$5.69	$3,985	MEANS 17-03-0415
Clean Backfill/Place/Compact Excavated Area (Lower 14")	467	CY	$12.42	$5,795	MEANS 17-03-0423
Gravel Base, 6 inches	167	CY	$34.55	$5,758	MEANS 18-01-0102 +
Asphalt stabilized base course 2" thick	56	CY	$47.74	$2,652	MEANS 18-01-0105
Asphalt wearing course 2" thick	83	TN	$86.87	$7,239	MEANS 18-02-0312
EJB					
Rough Grading	1162	SY	$5.15	$5,977	MEANS 17 03 0101
Fine Grading	1162	SY	$1.42	$1,651	MEANS 17 03 0103
Gravel Base, 6 inches	194	CY	$34.55	$6,689	MEANS 18-01-0102 +
Asphalt stabilized base course 2" thick	65	CY	$47.74	$3,081	MEANS 18-01-0105
Asphalt wearing course 2" thick	97	TN	$86.87	$8,409	MEANS 18-02-0312
U.S. Life/Wolf Properties					
Utility Maintenance/Repair (Water, Sewer)	200	LF	$26.25	$5,250	Source 3
Electric Power Pole Support/Replacement	6	EA	$5,000.00	$30,000	Source 3
Precast Drain Trench	440	LF	$158.50	$69,740	Century Precast Quote
Catch Basin with Sump	3	EA	$3,375.00	$10,125	Century Precast Quote
Trench Drain	240	LF	$27.00	$6,480	Century Precast Quote
Rough Grading	3800	SY	$5.15	$19,553	MEANS 17 03 0101
Fine Grading	3800	SY	$1.42	$5,402	MEANS 17 03 0103
Gravel Base, 6 inches	633	CY	$34.55	$21,882	MEANS 18-01-0102 +
Asphalt stabilized base course 2" thick	211	CY	$47.74	$10,077	MEANS 18-01-0105
Asphalt wearing course 2" thick	317	TN	$86.87	$27,509	MEANS 18-02-0312
Limited Regrading (Remainder of Developed Area)					
2"Asphalt over 10% of Area	110	TN	$86.87	$9,514	MEANS 18-02-0312
2 Coat Seal Coating	13,143	SY	$1.07	$14,063	Source 3
Installation of asphalt berm	690	FT	$4.20	$2,898	Source 3
SUBTOTAL				$294,369	
Mobilization/Demobilization	5%			$14,718	Source 3
Subcontractor General Conditions	15%			$44,155	Source 3
SUBTOTAL				$353,243	
Excavation (Drain Line)					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Source 3
Locate Drain Line	1	LS	$11,312.45	$11,312	Source 4
Cut and dispose of drain line	778	LF	$7.28	$5,662	Source 4
SUBTOTAL				$26,975	
Mobilization/Demobilization	5%			$1,349	Source 3
Subcontractor General Conditions	15%			$4,046	Source 3
SUBTOTAL				$32,370	
Excavation (Hg>620 mg/kg)					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Includes submittals
AC Demolition (Developed Area)	3,800	SY	$3.76	$14,288	Source 3
Soil Excavation and Truck Loading	7,140	CY	$5.54	$39,564	MEANS 17-03-0276
Clean Backfill/Place/Compact (below new AC cap)	6,783	CY	$12.42	$84,228	MEANS 17-03-0423, 1.2 Compaction Factor
Install temp stormwater diversion	1	LS	$1,103.85	$1,104	Source 4
Setup Temp SP area - bunded and lined HDPE	1	LS	$3,622.00	$3,622	Source 4
SUBTOTAL				$152,806	
Mobilization/Demobilization	5%			$7,640	Source 3
Subcontractor General Conditions	15%			$22,921	Source 3
SUBTOTAL				$183,367	

Alternative: **Soil Alternative S4** **COST ESTIMATE SUMMARY**

Name: **Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC**

Excavation of West Ditch					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Source 3
Silt Fencing - Wetland Area	1,200	FT	$3.36	$4,028	MEANS 18 05 0206
Coffer Dam and bypass piping	1.0	LS	$80,000.00	$80,000	Panther
Excavate and Load	450	CY	$5.54	$2,494	MEANS 17-03-0276
Grade, place geofabric	12,000	SF	$2.00	$24,000	Source 3
Geomembrane Liner	12,000	SF	$3.50	$42,000	Source 3
Clean Backfill/Place/Compact	540	CY	$12.42	$6,705	MEANS 17-03-0423
Supply and Installation of Vegetation	0.28	AC	$47,601.84	$13,113	Source 4
SUBTOTAL				$182,341	
Mobilization/Demobilization	5%			$9,117	Source 3
Subcontractor General Conditions	15%			$27,351	Source 3
SUBTOTAL				$218,809	
Removal of 55' Buffer					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Source 3
Silt Fencing - Wetland Area	2,400	FT	$3.36	$8,057	MEANS 18 05 0206
Clear and Grub	3.4	AC	$8,065.61	$27,774	MEANS 17-01-0106
Install stormwater control measures	3	EA	$7,489.93	$22,470	Source 4
Install temp stormwater diversion	1	LS	$1,103.85	$1,104	Source 4
Setup Temp SP area - bunded and lined HDPE	1	LS	$3,622.00	$3,622	Source 4
Soil Excavation and Truck Loading	22,400	CY	$5.54	$124,123	MEANS 17-03-0276
Clean Backfill/Place/Compact/Topsoil/Reseed	1	LS	$457,345.13	$457,345	Source 4
SUBTOTAL				$654,495	
Mobilization/Demobilization	5%			$32,725	Source 3
Subcontractor General Conditions	15%			$98,174	Source 3
SUBTOTAL				$785,394	
Compliance Monitoring and Health & Safety					
Environmental Controls	1	LS	$5,396.60	$5,397	Source 4
Analytical Requirements	1	LS	$79,794.00	$79,794	Source 3, Assume $2.60 per CY Excavated
Install Decon Shed for workers (Mobilization & Demobilization)	1	LS	$500.00	$500	Source 3
Decon Shed	3	MO	$1,042.53	$3,128	Source 4
Air Monitoring	51	DY	$717.50	$36,593	Source 4 + CH2M H&S
PPE Provisions for Workers (Initial)	8	EA	$300.95	$2,408	Source 4
PPE Provisions for Workers (Worker·Weeks)	74	EA	$127.31	$9,421	Source 4 + CH2M H&S
SUBTOTAL				$137,239	
Mobilization/Demobilization	5%			$6,862	Source 3
Subcontractor General Conditions	15%			$20,586	Source 3
SUBTOTAL				$164,687	
Subtitle D Landfill Transport and Disposal					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Includes submittals
Subtiltle D Transport & Landfill Disposal	675	TN	$68.00	$45,900	EWMI Quote
SUBTOTAL				$55,900	
Mobilization/Demobilization	5%			$2,795	Source 3
Subcontractor General Conditions	15%			$8,385	Source 3
SUBTOTAL				$67,080	
Treatment/Disposal of Hg-impacted Soil					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Includes submittals
Treatability Evaluation/Design	1	LS	$40,000.00	$40,000	Quote from Hazen
Load Material for Rail Transport	7,140	CY	$5.54	$39,564	MEANS 17-03-0276
Transport to Hazardous Waste Facility (Emelle, AL)	10,710	TN	$70.00	$749,700	Waste Management Quote, shipment by rail
Stabilization and disposal of Hg-Hazardous Soil	10,710	TN	$300.00	$3,213,000	Waste Management Quote
SUBTOTAL				$4,052,264	
Mobilization/Demobilization	5%			$202,613	Source 3
Subcontractor General Conditions	15%			$607,840	Source 3
SUBTOTAL				$4,862,717	
SUBTOTAL				$9,112,062	
Contingency	25%			$2,278,016	10% Scope + 15% Bid
SUBTOTAL				$11,390,078	
Project Management	5%			$569,504	**USEPA 2000, p. 5-13, $2M - $10M**
Remedial Design	8%			$911,206	**USEPA 2000, p. 5-13, $2M - $10M**
Construction Management	6%			$683,405	**USEPA 2000, p. 5-13, $2M - $10M**
SUBTOTAL				$2,164,115	
TOTAL CAPITAL COST				**$13,550,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Cap O&M					Year 1 to 50
Cap Semi-annual Inspection	8	Hr	$80.00	$640	
Cap Repair	1.0	LS	$18,102.65	$18,103	Assumes 1% of area
Cap Inspection and Repair Report	1.0	LS	$2,000.00	$2,000	Biennial Report to NJDEP
SUBTOTAL				$20,743	
Contingency	30%			$6,223	10% Scope + 20% Bid
SUBTOTAL				$26,965	
Project Management	5%			$1,348	
Technical Support	10%			$2,697	
TOTAL ANNUAL O&M COST				**$31,000**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
Field Sampling Plan (Air) and Sampling	1	1	LS	$6,200.00	$6,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	2	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	3	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	4	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	5	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
5 year Review	5	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	6	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet

Alternative: **Soil Alternative S4** **COST ESTIMATE SUMMARY**

Name: **Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC**

Air Monitoring Biennial Sampling Event	6	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	8	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	8	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
5 year Review	10	1	LS	$19,122.61	$19,123	
Air Monitoring Biennial Sampling Event	10	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	12	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	12	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	14	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	14	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
5 year Review	15	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	16	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	16	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	18	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	18	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
5 year Review	20	1	LS	$19,122.61	$19,123	
Air Monitoring Biennial Sampling Event	20	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	22	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	22	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	24	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	24	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
5 year Review	25	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	26	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	26	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	28	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	28	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
Asphalt Cap Replacement	30	1	LS	$199,618.59	$199,619	Assume 30% of 4" cap replaced
Air Monitoring Biennial Sampling Event	30	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	32	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	34	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	35	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	36	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	38	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	40	1	LS	$19,122.61	$19,123	
2 Year Biennial Certification	42	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	44	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	45	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	46	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	48	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	50	1	LS	$19,122.61	$19,123	
				Total	$490,000	
TOTAL ANNUAL PERIODIC COST					**$490,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$13,550,000	$13,550,000	$1.00	$13,550,000	
ANNUAL O&M COST - Cap	1 to 50	$1,550,000	$31,000	$13.80	$427,823	
PERIODIC COST	1	$6,200	$6,200	$0.93	$5,794	
PERIODIC COST	2	$4,123	$4,123	$0.87	$3,601	
PERIODIC COST	3	$3,200	$3,200	$0.82	$2,612	
PERIODIC COST	4	$4,123	$4,123	$0.76	$3,145	
PERIODIC COST	5	$18,200	$18,200	$0.71	$12,976	
PERIODIC COST	6	$7,323	$7,323	$0.67	$4,879	
PERIODIC COST	8	$7,323	$7,323	$0.58	$4,262	
PERIODIC COST	10	$22,323	$22,323	$0.51	$11,348	
PERIODIC COST	12	$7,323	$7,323	$0.44	$3,251	
PERIODIC COST	14	$7,323	$7,323	$0.39	$2,840	
PERIODIC COST	15	$15,000	$15,000	$0.36	$5,437	
PERIODIC COST	16	$7,323	$7,323	$0.34	$2,480	
PERIODIC COST	18	$7,323	$7,323	$0.30	$2,166	
PERIODIC COST	20	$22,323	$22,323	$0.26	$5,769	
PERIODIC COST	22	$7,323	$7,323	$0.23	$1,653	
PERIODIC COST	24	$7,323	$7,323	$0.20	$1,444	
PERIODIC COST	25	$15,000	$15,000	$0.18	$2,764	
PERIODIC COST	26	$7,323	$7,323	$0.17	$1,261	
PERIODIC COST	28	$7,323	$7,323	$0.15	$1,101	
PERIODIC COST	30	$202,819	$202,819	$0.13	$26,644	
PERIODIC COST	32	$4,123	$4,123	$0.11	$473	
PERIODIC COST	34	$4,123	$4,123	$0.10	$413	
PERIODIC COST	35	$15,000	$15,000	$0.09	$1,405	
PERIODIC COST	36	$4,123	$4,123	$0.09	$361	
PERIODIC COST	38	$4,123	$4,123	$0.08	$315	
PERIODIC COST	40	$19,123	$19,123	$0.07	$1,277	
PERIODIC COST	42	$4,123	$4,123	$0.06	$240	
PERIODIC COST	44	$4,123	$4,123	$0.05	$210	
PERIODIC COST	45	$15,000	$15,000	$0.05	$714	
PERIODIC COST	46	$4,123	$4,123	$0.04	$183	
PERIODIC COST	48	$4,123	$4,123	$0.04	$160	
PERIODIC COST	50	$19,123	$19,123	$0.03	$649	
		$15,600,000			$14,089,652	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$14,090,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).
2. R.S. Means Company. 2004. Environmental Remediation Cost Data - Unit Price, 10th Edition. R.S. Means Company and Talisman Partners, Ltd. Kingston, MA.
3. Historical CH2M HILL project cost information
4. Calculations using Historical CH2M HILL project cost information (separate worksheet)

Alternative: **Soil Alternative S5** **COST ESTIMATE SUMMARY**

Name: **Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Excavation of Other Properties to RDCSCC, and Use Restrictions on Undeveloped and Developed Areas**

Site: Ventron/Velsicol Site - Wood-Ridge, New Jersey
Location: Soil Media
Phase: Feasibility Study
Base Year: 2005
Date: Rev 05/31/2006

Description: Excavation of soil from the undeveloped fill area and developed area adjacent to warehouses.
Excavation of soil exceeding RDCSCC (Borough, EJB, Blum, Prince, Lin-Mor) and placement in the Undeveloped Fill Area. Excavation of soil from the 55-foot buffer area with placement below the cap.
Removal of approximately 1 foot of sediment from the west ditch and disposal at a nonhazardous waste landfill.
Treatment and off site disposal of Hg-hazardous soil ≥ 620 mg/kg.
Installation of asphalt cap in undeveloped fill area and EJB Property, along with upgrades of existing cap in developed area w/ repairs in excavated areas. Cap consists of 4-inch asphalt cover with 6 inches of gravel sub-base.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Site Establishment					
Support Area Establishment and Site Offices	8	MO	$6,623	$52,985	Source 3
SUBTOTAL				$52,985	
Mobilization/Demobilization	5%			$2,649	Source 3
Subcontractor General Conditions	15%			$7,948	Source 3
SUBTOTAL				$63,582	
Institutional Controls	4	LS	$25,000	$100,000	CH2M Est.
Including U.S. Life, Wolf, Railroad, Undeveloped Area					
SUBTOTAL				$100,000	
Asphalt Cap Area (Undeveloped Fill Area)					
Silt Fencing	3,500	FT	$3.36	$11,750	MEANS 18 05 0206
Clear and Grub	15.6	AC	$8,065.61	$126,206	MEANS 17 01 0106
Rough Grading	75,733	SY	$5.15	$389,693	MEANS 17 03 0101
Fine Grading	75,733	SY	$1.42	$107,669	MEANS 17 03 0103
Gravel Base, 6 inches	12,622	CY	$34.55	$436,095	MEANS 18-01-0102
Asphalt stabilized base course 2" thick	4,207	CY	$47.74	$200,842	MEANS 18-01-0105
Asphalt wearing course 2" thick	6,311	TN	$86.87	$548,257	MEANS 18-02-0312
Install asphalt Berm around perimeter	2400	FT	$4.20	$10,080	Source 3
SUBTOTAL				$1,830,591	
Mobilization/Demobilization	5%			$91,530	Source 3
Subcontractor General Conditions	15%			$274,589	Source 3
SUBTOTAL				$2,196,709	
Asphalt Cap Area (Developed Area and Off Site Properties)					
Off Site Properties (EJB, Blum, Prince, Lin-Mor, Borough)					
Rough Grading	8662	SY	$5.15	$44,569	MEANS 17 03 0101
Fine Grading	8662	SY	$1.42	$12,314	MEANS 17 03 0103
Gravel Base, 6 inches	1444	CY	$34.55	$49,876	MEANS 18-01-0102 + Source 3
Asphalt stabilized base course 2" thick	481	CY	$47.74	$22,970	MEANS 18-01-0105
Asphalt wearing course 2" thick	722	TN	$86.87	$62,704	MEANS 18-02-0312
Curb and Gutter along Ethel Boulevard	1640	LF	$35.00	$57,400	Source 3
Developed Area (US Life and Wolf Warehouses)					
Utility Maintenance/Repair (Water, Sewer)	200	LF	$26.25	$5,250	Source 3
Electric Power Pole Support/Replacement	6	EA	$5,000.00	$30,000	Source 3
Precast Drain Trench	440	LF	$158.50	$69,740	Century Precast Quote
Catch Basin with Sump	3	EA	$3,375.00	$10,125	Century Precast Quote
Trench Drain	240	LF	$27.00	$6,480	Century Precast Quote
Rough Grading	3800	SY	$5.15	$19,553	MEANS 17 03 0101
Fine Grading	3800	SY	$1.42	$5,402	MEANS 17 03 0103
Gravel Base, 6 inches	633	CY	$34.55	$21,882	MEANS 18-01-0102 + Source 3
Asphalt stabilized base course 2" thick	211	CY	$47.74	$10,077	MEANS 18-01-0105
Asphalt wearing course 2" thick	317	TN	$86.87	$27,509	MEANS 18-02-0312
Limited Regrading					
2"Asphalt over 10% of Remaining Asphalt Area	74	TN	$86.87	$6,429	MEANS 18-02-0312
2 Coat Seal Coating	10,043	SY	$1.07	$10,746	Source 3
Installation of asphalt curb/berm	690	FT	$4.20	$2,898	Source 3
SUBTOTAL				$475,925	
Mobilization/Demobilization	5%			$23,796	Source 3
Subcontractor General Conditions	15%			$71,389	Source 3
SUBTOTAL				$571,110	
Excavation (Drain Line)					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Source 3
Locate Drain Line	1	LS	$11,312.45	$11,312	Source 4
Cut and dispose of drain line	778	LF	$7.28	$5,662	Source 4
SUBTOTAL				$26,975	
Mobilization/Demobilization	5%			$1,349	Source 3
Subcontractor General Conditions	15%			$4,046	Source 3
SUBTOTAL				$32,370	
Excavation (Off Site Properties)					
EJB, Blum, Prince, Lin-Mor, Borough of Wood-Ridge					
AC Demolition	8,662	SY	$3.76	$32,568	Source 3
Excavation & loading of soil > RDCSCC to 2 ft bgs	6,800	CY	$5.54	$37,680	MEANS 17-03-0276
Cart excavated soil to undeveloped fill area	6,800	CY	$3.09	$20,995	Source 4 and CH2M H&S
Compact excavated soil in undeveloped fill area	6,800	CY	$5.69	$38,716	MEANS 17-03-0415
Clean backfill/place/compact excavated area (less AC/subbase)	5,273	CY	$12.42	$65,475	MEANS 17-03-0423 (1.2 compaction factor)
SUBTOTAL				$195,434	
Mobilization/Demobilization	5%			$9,772	Source 3
Subcontractor General Conditions	15%			$29,315	Source 3
SUBTOTAL				$234,520	
Excavation (Hg>620 mg/kg)					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Includes submittals;
AC Demolition (Wolf and U.S. Life)	3,800	SY	$3.76	$14,288	Source 3
Soil Excavation and Truck Loading	7,140	CY	$5.54	$39,564	MEANS 17-03-0276
Clean Backfill/Place/Compact	6,783	CY	$12.42	$84,228	MEANS 17-03-0423
Install temp stormwater diversion	1	LS	$1,103.85	$1,104	Source 4
Setup Temp SP area - bunded and lined HDPE	1	LS	$3,622.00	$3,622	Source 4
SUBTOTAL				$152,806	
Mobilization/Demobilization	5%			$7,640	Source 3
Subcontractor General Conditions	15%			$22,921	Source 3
SUBTOTAL				$183,367	

Alternative: **Soil Alternative S5** **COST ESTIMATE SUMMARY**

Name: **Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Excavation of Other Properties to RDCSCC, and Use Restrictions on Undeveloped and Developed Areas**

Excavation of West Ditch					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Source 3
Silt Fencing - Wetland Area	1,200	FT	$3.36	$4,028	MEANS 18 05 0206
Coffer Dam and bypass piping	1.0	LS	$80,000.00	$80,000	Panther
Excavate and Load	450	CY	$5.54	$2,494	Source 4
Grade, place geofabric	12,000	SF	$2.00	$24,000	Source 3
Geomembrane Liner	12,000	SF	$3.50	$42,000	Source 3
Clean Backfill/Place/Compact	540	CY	$12.42	$6,705	MEANS 17-03-0423
Supply and Installation of Vegetation	0.28	AC	$47,601.84	$13,113	Source 4
SUBTOTAL				$182,341	
Mobilization/Demobilization	5%			$9,117	Source 3
Subcontractor General Conditions	15%			$27,351	Source 3
SUBTOTAL				$218,809	
Removal of 55' Buffer					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Source 3
Silt Fencing - Wetland Area	2,400	FT	$3.36	$8,057	MEANS 18 05 0206
Clear and Grub	3.4	AC	$8,065.61	$27,774	MEANS 17-01-0106
Install stormwater control measures	3	EA	$7,489.93	$22,470	Source 4
Install temp stormwater diversion	1	LS	$1,103.85	$1,104	Source 4
Setup Temp SP area - bunded and lined HDPE	1	LS	$3,622.00	$3,622	Source 4
Soil Excavation and Truck Loading	22,400	CY	$5.54	$124,123	MEANS 17-03-0276
Clean Backfill/Place/Compact/Topsoil/Reseed	1	LS	$457,345.13	$457,345	Source 4
SUBTOTAL				$654,495	
Mobilization/Demobilization	5%			$32,725	Source 3
Subcontractor General Conditions	15%			$98,174	Source 3
SUBTOTAL				$785,394	
Compliance Monitoring and Health & Safety					
Environmental Controls	1	LS	$5,396.60	$5,397	Source 4
Analytical Requirements	1	LS	$95,654.00	$95,654	Source 3, Assume $2.60 per CY Excavated
Install Decon Shed for workers (Mobilization & Demobilization)	1	LS	$500.00	$500	Source 3
Decon Shed	3	MO	$1,042.53	$3,128	Source 4
Air Monitoring	58	DY	$717.50	$41,615	Source 4 + CH2M H&S
PPE Provisions for Workers (Initial)	8	EA	$300.95	$2,408	Source 4
PPE Provisions for Workers (Worker·Weeks)	84	EA	$127.31	$10,694	Source 4 + CH2M H&S
SUBTOTAL				$159,395	
Mobilization/Demobilization	5%			$7,970	Source 3
Subcontractor General Conditions	15%			$23,909	Source 3
SUBTOTAL				$191,274	
Nonhazardous Landfill Transport and Disposal					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Includes submittals
Nonhazardous Landfill Transport & Landfill Disposal	675	TN	$68.00	$45,900	EWMI Quote
SUBTOTAL				$55,900	
Mobilization/Demobilization	5%			$2,795	Source 3
Subcontractor General Conditions	15%			$8,385	Source 3
SUBTOTAL				$67,080	
Treatment/Disposal of Hg-impacted Soil					
Permits, Submittals & Workplans	1	LS	$ 10,000.00	$10,000	Includes submittals
Treatability Evaluation/Design	1	LS	$ 40,000.00	$40,000	Quote from Hazen
Load Material for Rail Transport	7,140	CY	$5.54	$39,564	MEANS 17-03-0276
Transport to Hazardous Waste Facility (Emelle, AL)	10,710	TN	$70.00	$749,700	Waste Management Quote, shipment by rail
Stabilization and disposal of Hg-Hazardous Soil	10,710	TN	$300.00	$3,213,000	Waste Management Quote
SUBTOTAL				$4,052,264	
Mobilization/Demobilization	5%			$202,613	Source 3
Subcontractor General Conditions	15%			$607,840	Source 3
SUBTOTAL				$4,862,717	
SUBTOTAL				$9,506,932	
Contingency	25%			$2,376,733	10% Scope + 15% Bid
SUBTOTAL				$11,883,665	
Project Management	5%			$594,183	**USEPA 2000, p. 5-13, $2M - $10M**
Remedial Design	8%			$950,693	**USEPA 2000, p. 5-13, $2M - $10M**
Construction Management	6%			$713,020	**USEPA 2000, p. 5-13, $2M - $10M**
SUBTOTAL				$2,257,896	
TOTAL CAPITAL COST				**$14,140,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Cap O&M					Year 1 to 50
Cap Semi-annual Inspection	8	Hr	$80.00	$640	
Cap Repair	1.0	LS	$17,844.57	$17,845	Assumes 1% of area requires repair
Cap Inspection and Repair Report	1.0	LS	$2,000.00	$2,000	Biennial Report to NJDEP
SUBTOTAL				$20,485	
Contingency	30%			$6,145	10% Scope + 20% Bid
SUBTOTAL				$26,630	
Project Management	5%			$1,331	
Technical Support	10%			$2,663	
TOTAL ANNUAL O&M COST				**$30,600**	

Alternative: **Soil Alternative S5** **COST ESTIMATE SUMMARY**

Name: **Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Excavation of Other Properties to RDCSCC, and Use Restrictions on Undeveloped and Developed Areas**

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
Field Sampling Plan (Air) and Sampling	1	1	LS	$6,200.00	$6,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	2	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	3	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	4	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	5	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
5 year Review	5	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	6	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	6	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	8	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	8	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
5 year Review	10	1	LS	$19,122.61	$19,123	
Air Monitoring Biennial Sampling Event	10	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	12	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	12	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	14	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	14	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
5 year Review	15	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	16	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	16	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	18	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	18	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
5 year Review	20	1	LS	$19,122.61	$19,123	
Air Monitoring Biennial Sampling Event	20	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	22	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	22	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	24	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	24	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
5 year Review	25	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	26	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	26	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	28	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	28	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
Asphalt Cap Replacement	30	1	LS	$197,095.83	$197,096	Assume 30% of 4" cap replaced
Air Monitoring Biennial Sampling Event	30	1	LS	$3,200.00	$3,200	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	32	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	34	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	35	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	36	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	38	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	40	1	LS	$19,122.61	$19,123	
2 Year Biennial Certification	42	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	44	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	45	1	LS	$15,000.00	$15,000	
2 Year Biennial Certification	46	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	48	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	50	1	LS	$19,122.61	$19,123	
				Total	$490,000	
TOTAL ANNUAL PERIODIC COST					**$490,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$14,140,000	$14,140,000	$1.00	$14,140,000	
ANNUAL O&M COST - Cap	1 to 50	$1,530,000	$30,600	$13.80	$422,303	
PERIODIC COST	1	$6,200	$6,200	$0.93	$5,794	
PERIODIC COST	2	$4,123	$4,123	$0.87	$3,601	
PERIODIC COST	3	$3,200	$3,200	$0.82	$2,612	
PERIODIC COST	4	$4,123	$4,123	$0.76	$3,145	
PERIODIC COST	5	$18,200	$18,200	$0.71	$12,976	
PERIODIC COST	6	$7,323	$7,323	$0.67	$4,879	
PERIODIC COST	8	$7,323	$7,323	$0.58	$4,262	
PERIODIC COST	10	$22,323	$22,323	$0.51	$11,348	
PERIODIC COST	12	$7,323	$7,323	$0.44	$3,251	
PERIODIC COST	14	$7,323	$7,323	$0.39	$2,840	
PERIODIC COST	15	$15,000	$15,000	$0.36	$5,437	
PERIODIC COST	16	$7,323	$7,323	$0.34	$2,480	
PERIODIC COST	18	$7,323	$7,323	$0.30	$2,166	
PERIODIC COST	20	$22,323	$22,323	$0.26	$5,769	
PERIODIC COST	22	$7,323	$7,323	$0.23	$1,653	
PERIODIC COST	24	$7,323	$7,323	$0.20	$1,444	
PERIODIC COST	25	$15,000	$15,000	$0.18	$2,764	
PERIODIC COST	26	$7,323	$7,323	$0.17	$1,261	
PERIODIC COST	28	$7,323	$7,323	$0.15	$1,101	
PERIODIC COST	30	$200,296	$200,296	$0.13	$26,312	
PERIODIC COST	32	$4,123	$4,123	$0.11	$473	
PERIODIC COST	34	$4,123	$4,123	$0.10	$413	
PERIODIC COST	35	$15,000	$15,000	$0.09	$1,405	
PERIODIC COST	36	$4,123	$4,123	$0.09	$361	
PERIODIC COST	38	$4,123	$4,123	$0.08	$315	
PERIODIC COST	40	$19,123	$19,123	$0.07	$1,277	
PERIODIC COST	42	$4,123	$4,123	$0.06	$240	
PERIODIC COST	44	$4,123	$4,123	$0.05	$210	
PERIODIC COST	45	$15,000	$15,000	$0.05	$714	
PERIODIC COST	46	$4,123	$4,123	$0.04	$183	
PERIODIC COST	48	$4,123	$4,123	$0.04	$160	
PERIODIC COST	50	$19,123	$19,123	$0.03	$649	
		$16,200,000			$14,673,800	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$14,670,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).
2. R.S. Means Company. 2004. Environmental Remediation Cost Data - Unit Price, 10th Edition. R.S. Means Company and Talisman Partners, Ltd. Kingston, MA.
3. Historical CH2M HILL project cost information
4. Calculations using Historical CH2M HILL project cost information (separate worksheet)

Alternative: **Soil Alternative S6** **COST ESTIMATE SUMMARY**

Name: **Excavation of Developed Area with ≥ 620 mg/kg Mercury, Excavation of Undeveloped Area and Other Properties to RDCSCC, and Use Restrictions on Developed Area**

Site: Ventron/Velsicol Site - Wood-Ridge, New Jersey
Location: Soil Media
Phase: Feasibility Study
Base Year: 2005
Date: Rev 04/06/2006

Description: Excavation of entire undeveloped fill area (including excavation of buffer area described in previous alternatives). Assumed 75% of excavated soil will require stabilization/ treatment prior to disposal at hazardous waste landfill. Remaining undeveloped fill area soil will not require treatment and will be disposed of at nonhazardous waste landfill. Excavation of soil ≥ 620 mg/kg in developed area adjacent to warehouses. Excavation (Borough, EJB, Blum, Prince, Lin-Mor) to RDCSCC levels with disposal to nonhazardous waste landfill. Remaining asphalt caps in developed area will be upgraded. Excavation of west ditch to approximately 1 foot with installation of concrete liner system and disposal at nonhazardous waste landfill.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Site Establishment					
Support Area Establishment and Site Offices	30	MO	$6,623	$198,693	Source 3
SUBTOTAL				$198,693	
Mobilization/Demobilization	5%			$9,935	Source 3
Subcontractor General Conditions	15%			$29,804	Source 3
SUBTOTAL				$238,432	
Institutional Controls (U.S. Life, Wolf, Railroad)	3	LS	$25,000.00	$75,000	Source 1
Excavate and AC Cap (Developed Area and Off Site Properties)					
Off Site Properties (EJB, Blum, Prince, Lin-Mor, Borough)					
AC Demoliton	8,662	SY	$3.76	$32,568	Source 3
Excavation & Loading of Soil	6,800	CY	$5.54	$37,680	MEANS 17-03-0276
Cart & Dispose to Subtitle D Landfill	10,200	TN	$68.00	$693,600	EWMI Quote
Import and Place Clean Fill below AC and Gravel Base Layers	5,273	CY	$12.42	$65,475	MEANS 17-03-0423
Curb and Gutter along Ethel Boulevard	1640	LF	$35.00	$57,400	CH2M Est.
Rough Grading	8,662	SY	$5.15	$44,569	MEANS 17 03 0101
Fine Grading	8,662	SY	$1.42	$12,314	MEANS 17 03 0103
Gravel Base, 6 inches	1,444	CY	$34.55	$49,876	MEANS 18-01-0102
Asphalt stabilized base course 2" thick	481	CY	$47.74	$22,970	MEANS 18-01-0105
Asphalt wearing course 2" thick	722	TN	$86.87	$62,704	MEANS 18-02-0312
Developed Area ≥ 620 mg/kg (U.S. Life and Wolf Warehouses)					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Includes submittals;
AC Demolition	3,800	SY	$3.76	$14,288	CH2M Est.
Soil Excavation and Truck Loading	5,040	CY	$5.54	$27,928	MEANS 17-03-0276
Subtitle C Transport	7,560	TN	$70.00	$529,200	Waste Management Quote, Ship by Rail
Stabilization/Treatment and Disposal	7,560	TN	$300.00	$2,268,000	Waste Management Quote
Clean Backfill/Place/Compact below AC & Gravel Base	4,781	CY	$12.42	$59,372	Source 3, 20% compaction factor
Install temp stormwater diversion	1	LS	$1,103.85	$1,104	Source 4
Utility Maintenance/Repair (Water, Sewer)	200	LF	$26.25	$5,250	Source 3
Electric Power Pole Support/Replacement	6	EA	$5,000.00	$30,000	Source 3
Precast Drain Trench	440	LF	$158.50	$69,740	Century Precast Quote
Catch Basin with Sump	3	EA	$3,375.00	$10,125	Century Precast Quote
Trench Drain	240	LF	$27.00	$6,480	Century Precast Quote
Rough Grading	3,800	SY	$5.15	$19,553	MEANS 17 03 0101
Fine Grading	3,800	SY	$1.42	$5,402	MEANS 17 03 0103
Gravel Base, 6 inches	633	CY	$34.55	$21,882	MEANS 18-01-0102
Asphalt stabilized base course 2" thick	211	CY	$47.74	$10,077	MEANS 18-01-0105
Asphalt wearing course 2" thick	317	TN	$86.87	$27,509	MEANS 18-020312
Limited Regrading (AC Repair Areas)					
2" Asphalt over 10% of Remaining Area	84	TN	$86.87	$7,270	MEANS 18-01-0105
2 Coat Seal Coating	10,043	SY	$1.07	$10,746	Source 3
Installation of asphalt berm	690	FT	$4.20	$2,898	Source 3
SUBTOTAL				$4,215,980	
Mobilization/Demobilization	5%			$210,799	Source 3
Subcontractor General Conditions	15%			$632,397	Source 3
SUBTOTAL				$5,059,176	
Clearing and Grubbing (Undeveloped Fill Area)					
Clear and Grub	19.1	AC	$8,065.61	$153,980	MEANS 17 01 0106
SUBTOTAL				$153,980	
Mobilization/Demobilization	5%			$7,699	Source 3
Subcontractor General Conditions	15%			$23,097	Source 3
SUBTOTAL				$184,776	
Excavation (Drain Line)					
Locate Drain Line	1	LS	$11,312.45	$11,312	Source 4
Cut & Disposal of Drain Line	778	LF	$7.28	$5,662	Source 4
SUBTOTAL				$16,975	
Mobilization/Demobilization	5%			$849	Source 3
Subcontractor General Conditions	15%			$2,546	Source 3
SUBTOTAL				$20,370	
Excavation (Undeveloped Fill Area)					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Includes submittals;
Silt Fencing	3,500	FT	$3.36	$11,750	MEANS 18 05 0206
Soil Excavation and Truck Loading	122,500	CY	$5.54	$678,797	MEANS 17-03-0276
Carting of Soil to loading area for off-site disposal	122,500	CY	$3.19	$390,775	Source 4
Install temp stormwater diversion	1	LS	$15,453.90	$15,454	Source 4
SUBTOTAL				$1,106,776	
Mobilization/Demobilization	5%			$55,339	Source 3
Subcontractor General Conditions	15%			$166,016	Source 3
SUBTOTAL				$1,328,131	

Alternative: Name: **Soil Alternative S6** **COST ESTIMATE SUMMARY**

Excavation of Developed Area with ≥ 620 mg/kg Mercury, Excavation of Undeveloped Area and Other Properties to RDCSCC, and Use Restrictions on Developed Area

	QTY	UNIT	UNIT COST	TOTAL	NOTES
Excavation of West Ditch					
Application for permits	1	LS	$10,000.00	$10,000	Source 3
Silt Fencing - Wetland Area	1,200	FT	$3.36	$4,028	MEANS 18 05 0206
Coffer Dam and bypass piping	1.0	LS	$80,000.00	$80,000	Panther
Excavate and Load	450	CY	$5.54	$2,494	MEANS 17-03-0276
Clean Backfill/Place/Compact	540	CY	$12.42	$6,705	MEANS 17-03-0423
Concrete Liner (Segmented Blocks)	12,000	SF	$8.00	$96,000	Source 3
Subtiltle D Transport & Landfill Disposal	675	TN	$68.00	$45,900	EWMI Quote
SUBTOTAL				$245,127	
Mobilization/Demobilization	5%			$12,256	Source 3
Subcontractor General Conditions	15%			$36,769	Source 3
SUBTOTAL				$294,153	
Compliance Monitoring and Health & Safety					
Environmental Controls	1	LS	$5,396.60	$5,397	Source 4
Analytical Requirements	1	LS	$350,454	$350,454	Source 3, Assume $2.60 per CY Excavated
Install Decon Shed for workers (Mobilization & Demobilization)	1	LS	$500.00	$500	Source 3
Decon Shed	24	MO	$1,042.53	$25,021	Source 4
Air Monitoring	488	DY	$717.50	$350,141	Source 4 + CH2M H&S
PPE Provisions for Workers (Initial)	16	EA	$300.95	$4,815	Source 4
PPE Provisions for Workers (Worker·Weeks)	686	EA	$127.31	$87,310	Source 4 + CH2M H&S
SUBTOTAL				$823,637	
Mobilization/Demobilization	5%			$41,182	Source 3
Subcontractor General Conditions	15%			$123,546	Source 3
SUBTOTAL				$988,365	
Stabilization/Treatment & Soil Disposal (Undeveloped Area)					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Source 3
Treatability Evaluation/Design	1	LS	$40,000	$40,000	Hazen Quote
Load Material for Off-site Transport	122,500	CY	$5.54	$678,797	MEANS 17-03-0276
Subtitle C Transport (75% Haz)	137,813	TN	$70.00	$9,646,875	Waste Management Quote, Ship by Rail
Subtitle C Stabilization and Disposal	137,813	TN	$300.00	$41,343,750	Waste Management Quote
Subtitle D Transport & Landfill Disposal (non-haz)	45,938	TN	$68.00	$3,123,750	EWMI Quote
SUBTOTAL				$54,843,172	
Mobilization/Demobilization	5%			$2,742,159	Source 3
Subcontractor General Conditions	15%			$8,226,476	Source 3
SUBTOTAL				$65,811,807	
Import & Place Clean Backfill and Seed					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Source 3
Clean Backfill/Place/Compact	147,000	CY	$12.42	$1,825,365	MEANS 17-03-0423
Import & Place 6" Clean Topsoil	15,400	CY	$22.00	$338,800	Source 3
Import & Place 2" Mulch	5,133	CY	$24.53	$125,921	Source 4
Fine Grading	92,400	SY	$1.42	$131,363	MEANS 17 03 0103
Hydroseeding	681,600	SF	$0.07	$47,712	Source 3
SUBTOTAL				$2,479,161	
Mobilization/Demobilization	5%			$123,958	Source 3
Subcontractor General Conditions	15%			$371,874	Source 3
SUBTOTAL				$2,974,993	
SUBTOTAL				$76,975,201	
Contingency	25%			$19,243,800	10% Scope + 15% Bid
SUBTOTAL				$96,219,002	
Project Management	5%			$4,810,950	**USEPA 2000, p. 5-13, >$10M**
Remedial Design	6%			$5,773,140	**USEPA 2000, p. 5-13, >$10M**
Construction Management	6%			$5,773,140	**USEPA 2000, p. 5-13, >$10M**
SUBTOTAL				$16,357,230	
TOTAL CAPITAL COST				**$112,580,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Cap Semi-annual Inspection	8	Hr	$80.00	$640	
Cap Repair	1	LS	$1,024.40	$1,024	Assumes 1% of area requires repair annually
Cap Inspection and Repair Report	1	LS	$2,000.00	$2,000	Biennial Report to NJDEP
SUBTOTAL				$3,664	
Contingency	30%			$1,099	10% Scope + 20% Bid
SUBTOTAL				$4,764	
Project Management	5%			$238	
Technical Support	10%			$476	
TOTAL ANNUAL O&M COST				**$5,500**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
Air Monitoring Field Sampling Plan and Sampling Event	1	1	LS	$6,200	$6,200	CH2M HILL Estimate, see Source 5
2 Year Biennial Certification	2	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	3	1	LS	$3,200	$3,200	CH2M HILL Estimate, see Source 5
2 Year Biennial Certification	4	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	5	1	LS	$3,200	$3,200	CH2M HILL Estimate, see Source 5
5 year Review	5	1	LS	$15,000	$15,000	
2 Year Biennial Certification	6	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	6	1	LS	$3,200	$3,200	CH2M HILL Estimate, see Source 5
2 Year Biennial Certification	8	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	8	1	LS	$3,200	$3,200	CH2M HILL Estimate, see Source 5
5 year Review	10	1	LS	$19,123	$19,123	

Alternative: **Soil Alternative S6** **COST ESTIMATE SUMMARY**

Name: **Excavation of Developed Area with ≥ 620 mg/kg Mercury, Excavation of Undeveloped Area and Other Properties to RDCSCC, and Use Restrictions on Developed Area**

Air Monitoring Biennial Sampling Event	10	1	LS	$3,200	$3,200	CH2M HILL Estimate, see Source 5
2 Year Biennial Certification	12	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	12	1	LS	$3,200	$3,200	CH2M HILL Estimate, see Source 5
2 Year Biennial Certification	14	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	14	1	LS	$3,200	$3,200	CH2M HILL Estimate, see Source 5
5 year Review	15	1	LS	$15,000	$15,000	
2 Year Biennial Certification	16	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	16	1	LS	$3,200	$3,200	CH2M HILL Estimate, see Source 5
2 Year Biennial Certification	18	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	18	1	LS	$3,200	$3,200	CH2M HILL Estimate, see Source 5
5 year Review	20	1	LS	$19,123	$19,123	
Air Monitoring Biennial Sampling Event	20	1	LS	$3,200	$3,200	CH2M HILL Estimate, see Source 5
2 Year Biennial Certification	22	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	22	1	LS	$3,200	$3,200	CH2M HILL Estimate, see Source 5
2 Year Biennial Certification	24	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	24	1	LS	$3,200	$3,200	CH2M HILL Estimate, see Source 5
5 year Review	25	1	LS	$15,000	$15,000	
2 Year Biennial Certification	26	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	26	1	LS	$3,200	$3,200	CH2M HILL Estimate, see Source 5
2 Year Biennial Certification	28	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
Air Monitoring Biennial Sampling Event	28	1	LS	$3,200	$3,200	CH2M HILL Estimate, see Source 5
Asphalt Cap Replacement	30	1	LS	$43,339	$43,339	Assume 30% of 4" cap replaced
Air Monitoring Biennial Sampling Event	30	1	LS	$3,200	$3,200	CH2M HILL Estimate, see Source 5
2 Year Biennial Certification	32	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	34	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	35	1	LS	$15,000	$15,000	
2 Year Biennial Certification	36	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	38	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	40	1	LS	$19,123	$19,123	
2 Year Biennial Certification	42	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	44	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	45	1	LS	$15,000	$15,000	
2 Year Biennial Certification	46	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
2 Year Biennial Certification	48	1	LS	$4,122.61	$4,123	See "Alt S2 Calc's" Sheet
5 year Review	50	1	LS	$19,123	$19,123	
				Total	$330,000	
TOTAL ANNUAL PERIODIC COST					**$330,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$112,580,000	$112,580,000	$1.00	$112,580,000	
ANNUAL O&M COST	1 to 50	$275,000	$5,500	$13.80	$75,904	
PERIODIC COST	1	$6,200	$6,200	$0.93	$5,794	
PERIODIC COST	2	$4,123	$4,123	$0.87	$3,601	
PERIODIC COST	3	$3,200	$3,200	$0.82	$2,612	
PERIODIC COST	4	$4,123	$4,123	$0.76	$3,145	
PERIODIC COST	5	$18,200	$18,200	$0.71	$12,976	
PERIODIC COST	6	$7,323	$7,323	$0.67	$4,879	
PERIODIC COST	8	$7,323	$7,323	$0.58	$4,262	
PERIODIC COST	10	$22,323	$22,323	$0.51	$11,348	
PERIODIC COST	12	$7,323	$7,323	$0.44	$3,251	
PERIODIC COST	14	$7,323	$7,323	$0.39	$2,840	
PERIODIC COST	15	$15,000	$15,000	$0.36	$5,437	
PERIODIC COST	16	$7,323	$7,323	$0.34	$2,480	
PERIODIC COST	18	$7,323	$7,323	$0.30	$2,166	
PERIODIC COST	20	$22,323	$22,323	$0.26	$5,769	
PERIODIC COST	22	$7,323	$7,323	$0.23	$1,653	
PERIODIC COST	24	$7,323	$7,323	$0.20	$1,444	
PERIODIC COST	25	$15,000	$15,000	$0.18	$2,764	
PERIODIC COST	26	$7,323	$7,323	$0.17	$1,261	
PERIODIC COST	28	$7,323	$7,323	$0.15	$1,101	
PERIODIC COST	30	$46,539	$46,539	$0.13	$6,114	
PERIODIC COST	32	$4,123	$4,123	$0.11	$473	
PERIODIC COST	34	$4,123	$4,123	$0.10	$413	
PERIODIC COST	35	$15,000	$15,000	$0.09	$1,405	
PERIODIC COST	36	$4,123	$4,123	$0.09	$361	
PERIODIC COST	38	$4,123	$4,123	$0.08	$315	
PERIODIC COST	40	$19,123	$19,123	$0.07	$1,277	
PERIODIC COST	42	$4,123	$4,123	$0.06	$240	
PERIODIC COST	44	$4,123	$4,123	$0.05	$210	
PERIODIC COST	45	$15,000	$15,000	$0.05	$714	
PERIODIC COST	46	$4,123	$4,123	$0.04	$183	
PERIODIC COST	48	$4,123	$4,123	$0.04	$160	
PERIODIC COST	50	$19,123	$19,123	$0.03	$649	
		$113,200,000			$112,747,203	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$112,750,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).
2. R.S. Means Company. 2004. Environmental Remediation Cost Data - Unit Price, 10th Edition. R.S. Means Company and Talisman Partners, Ltd. Kingston, MA.
3. Historical CH2M HILL project cost information
4. Calculations using Historical CH2M HILL project cost information (separate worksheet)
5. Based on NIOSH Method 6009, 3 sampling stations, 2 samples/station, 1 field duplicate, 1 field blank

Alternative: **Soil Alternative S7** **COST ESTIMATE SUMMARY**

Name: **Excavation of Undeveloped, Developed, and Other Properties to RDCSCC and Use Restrictions on the Railroad**

Site: Ventron/Velsicol Site - Wood-Ridge, New Jersey
Location: Soil Media
Phase: Feasibility Study
Base Year: 2005
Date: Rev 04/06/2006

Description: Total excavation of soil where PRGs are > RDCSCC. Ditch soil and sediment excavated to four feet and soil and sediment will be disposed at a nonhazardous waste landfill. Characteristically hazardous soil will be stabilized/treated and disposed at hazardous waste landfill. Costs for building reconstruction added as line item not included in present worth analysis. Institutional controls for railroad property.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Site Establishment					
Support Area Establishment and Site Offices	38	MO	$6,623.10	$251,678	Source 3
SUBTOTAL				$251,678	
Mobilization/Demobilization	5%			$12,584	Source 3
Subcontractor General Conditions	15%			$37,752	Source 3
SUBTOTAL				$302,013	
Institutional Controls (Norfolk Southern)	1	LS	$25,000.00	$25,000	Source 3
Excavation (Drain Line)					
Locate Drain Line	1	LS	$11,312.45	$11,312	Source 4
Cut & Disposal of Drain Line	778	LF	$7.28	$5,662	Source 4
SUBTOTAL				$16,975	
Mobilization/Demobilization	5%			$849	Source 3
Subcontractor General Conditions	15%			$2,546	Source 3
SUBTOTAL				$20,370	
Clearing and Grubbing (Undeveloped Fill Area)					
Clear and Grub	19.1	AC	$8,065.61	$153,980	MEANS 17 01 0106
Demoliton & disposal of rail line	550	FT	$30.70	$16,885	Source 3
SUBTOTAL				$170,865	
Mobilization/Demobilization	5%			$8,543	Source 3
Subcontractor General Conditions	15%			$25,630	Source 3
SUBTOTAL				$205,038	
Building Demolition & Clearing (Developed Area)					
Permits, Submittals & Workplans	1	LS	$10,000	$10,000	Includes submittals;
Demolish Building Structures	3,966,000	CF	$0.28	$1,110,480	Assume 2 story high typical brick & concrete construction
Decommission and Remove Utilities	1	LS	$200,000	$200,000	CH2M Estimate
Asbestos, Lead and PCB Survey	1	LS	$10,000	$10,000	CH2M Estimate
Asbestos Removal	1	LS	$50,000	$50,000	CH2M Estimate
Demolition of Existing Asphalt Pavement 3" thick	16943	SY	$3.76	$63,704	Source 3
Disposal of Asphalt	1412	CY	$25.00	$35,297	Source 3
SUBTOTAL				$1,479,482	
Mobilization/Demobilization	5%			$73,974	Source 3
Subcontractor General Conditions	15%			$221,922	Source 3
SUBTOTAL				$1,775,378	
Excavation of West Ditch					
Application for permits	1	LS	$10,000	$10,000	CH2M Est.
Silt Fencing - Wetland Area	1,200	FT	$3.36	$4,028	MEANS 18 05 0206
Coffer Dam and bypass piping	1.0	LS	$80,000	$80,000	Panther
Excavate and Load	1,800	CY	$5.54	$9,974	MEANS 17-03-0276
Clean Backfill/Place/Compact	2,160	CY	$12.42	$26,822	MEANS 17-03-0423
Place Concrete Liner	12,000	SF	$8.00	$96,000	Source 3
Subtiltle D Transport & Landfill Disposal	2,700	TN	$68.00	$183,600	EWMI Quote
SUBTOTAL				$410,424	
Mobilization/Demobilization	5%			$20,521	Source 3
Subcontractor General Conditions	15%			$61,564	Source 3
SUBTOTAL				$492,509	
Excavation (Entire Site)					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Includes submittals;
Silt Fencing	6,900	FT	$3.36	$23,164	MEANS 18 05 0206
Soil Excavation and Truck Loading	157,500	CY	$5.54	$872,739	MEANS 17-03-0276
Install temp stormwater diversion	1	LS	$23,180.85	$23,181	Source 4
SUBTOTAL				$929,084	
Mobilization/Demobilization	5%			$46,454	Source 3
Subcontractor General Conditions	15%			$139,363	Source 3
SUBTOTAL				$1,114,901	
Compliance Monitoring and Health & Safety					
Environmental Controls	1	LS	$5,396.60	$5,397	Source 4
Analytical Requirements	1	LS	$409,500	$409,500	Source 3, Assume $2.60 per CY Excavated
Install Decon Shed for workers (Mobilization & Demobilization)	1	LS	$500.00	$500	Source 3
Decon Shed	28	MO	$1,042.53	$29,191	Source 4
Air Monitoring	591	DY	$717.50	$424,044	Source 4 + CH2M H&S
PPE Provisions for Workers (Initial)	16	EA	$300.95	$4,815	Source 4
PPE Provisions for Workers (Worker·Weeks)	827	EA	$127.31	$105,337	Source 4 + CH2M H&S
SUBTOTAL				$978,783	
Mobilization/Demobilization	5%			$48,939	Source 3
Subcontractor General Conditions	15%			$146,817	Source 3
SUBTOTAL				$1,174,540	
Stabilization/Treatment and Disposal					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	Includes submittals;
Treatability Evaluation/Design	1	LS	$40,000.00	$40,000	Hazen Quote
Subtitle C Transport	177,150	TN	$70.00	$12,400,500	Waste Management Quote, ship by rail
Subtitle C Stabilization and Disposal	177,150	TN	$300.00	$53,145,000	Waste Management Quote (Emelle, AL)
Subtiltle D Transport & Landfill Disposal	59,100	TN	$68.00	$4,018,800	EWMI Quote, assume 1.5 TN/CY
SUBTOTAL				$69,614,300	
Mobilization/Demobilization	5%			$3,480,715	Source 3
Subcontractor General Conditions	15%			$10,442,145	Source 3
SUBTOTAL				$83,537,160	

Alternative: **Soil Alternative S7** **COST ESTIMATE SUMMARY**

Name: **Excavation of Undeveloped, Developed, and Other Properties to RDCSCC and Use Restrictions on the Railroad**

Import & Place Clean Backfill					
Permits, Submittals & Workplans	1	LS	$10,000.00	$10,000	CH2M Est.
Clean Backfill/Place/Compact	189,000	CY	$12.42	$2,346,898	MEANS 17-03-0423
Import & Place 6" Clean Topsoil	21,000	CY	$22.00	$462,000	Source 3
Import & Place 2" Mulch	7,000	CY	$24.53	$171,710	Source 4
Grade Developed & Non-Developed Areas	125,850	SY	$1.42	$178,918	MEANS 17 03 0103
Vegetation of Undeveloped Fill Area	831,600	SF	$0.07	$58,212	Source 3
SUBTOTAL				$3,227,738	
Mobilization/Demobilization	5%			$161,387	Source 3
Subcontractor General Conditions	15%			$484,161	Source 3
SUBTOTAL				$3,873,286	
SUBTOTAL				$92,520,194	
Contingency	25%			$23,130,049	10% Scope + 15% Bid
SUBTOTAL				$115,650,243	
Project Management	5%			$5,782,512	**USEPA 2000, p. 5-13, >$10M**
Remedial Design	6%			$6,939,015	**USEPA 2000, p. 5-13, >$10M**
Construction Management	6%			$6,939,015	**USEPA 2000, p. 5-13, >$10M**
SUBTOTAL				$19,660,541	
TOTAL CAPITAL COST				**$135,300,000**	
Building Reconstruction					
Building Construction	158,642	SF	$70.00	$11,104,940	CH2M Estimate
SUBTOTAL				$11,104,940	
Mobilization/Demobilization	5%			$555,247	Source 3
Subcontractor General Conditions	15%			$1,665,741	Source 3
SUBTOTAL				**$13,325,928**	**Not Included in Present Worth Evaluation**

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	Hr	$0.00	$0	
TOTAL ANNUAL O&M COST				**$0**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	1	LS	$0.00	$0	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$135,300,000	$135,300,000	$1.00	$135,300,000	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$135,300,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).
2. R.S. Means Company. 2004. Environmental Remediation Cost Data - Unit Price, 10th Edition. R.S. Means Company and Talisman Partners, Ltd. Kingston, MA.
3. Historical CH2M HILL project cost information
4. Calculations using Historical CH2M HILL project cost information (separate worksheet)

Groundwater Media Alternatives Costs

COMPARISON OF TOTAL COST - GROUNDWATER REMEDIAL ALTERNATIVES

Site: Ventron/Velsicol Superfund Site
Media: Groundwater
Phase: OU 1 Feasibility Study

Base Year: 2005
Date: Rev 04/06/2006

	Groundwater Alternative G1 No Further Action	**Groundwater Alternative G2** Natural Attenuation and Institutional Controls	**Groundwater Alternative G3** Hydraulic Controls via Pumping	**Groundwater Alternative G4** Groundwater Pump and Treat	**Groundwater Alternative G5** Vertical Hydraulic Barrier	**Groundwater Alternative G6** Vertical Hydraulic Barrier Around Site Perimeter
Total Project Duration (Years)	50	50	50	25	50	50
Capital Cost	$0	$25,000	$1,020,000	$2,300,000	$1,360,000	$4,230,000
Annual O&M Cost	$0	$24,000	$180,000	$740,000	$24,000	$166,000
Total Periodic Cost	$150,000	$150,000	$150,000	$75,000	$150,000	$150,000
Total Present Value of Alternative	$36,000	$520,000	$3,670,000	$10,950,000	$1,860,000	$6,690,000

Disclaimer: The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternatives. This is an order-of-magnitude cost estimate that is expected to be within +50 to -30 percent of the actual project costs.

Alternative: **Groundwater Alternative G1** **COST ESTIMATE SUMMARY**
Name: **No Further Action**

Site: Ventron/Velsicol Superfund Site
Media: Groundwater
Phase: OU 1 Feasibility Study
Base Year: 2005
Date: Rev 04/06/2006

Description: No additional actions undertaken other than the required 5-year reviews.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
No construction				$0	
TOTAL CAPITAL COST				**$0**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
None	0	LS	$0	$0	
TOTAL ANNUAL O&M COST				**$0**	

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
				Total	**$150,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$0	$0	1.000	$0	
ANNUAL O&M COST	1 to 50	$0	$0	13.80	$0	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$15,000	$15,000	0.51	$7,625	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$15,000	$15,000	0.26	$3,876	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
PERIODIC COST	30	$15,000	$15,000	0.13	$1,971	
PERIODIC COST	35	$15,000	$15,000	0.09	$1,405	
PERIODIC COST	40	$15,000	$15,000	0.07	$1,002	
PERIODIC COST	45	$15,000	$15,000	0.05	$714	
PERIODIC COST	50	$15,000	$15,000	0.03	$509	
		$150,000			$35,997	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$36,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative Name: **Groundwater Alternative G2** — **Natural Attenuation and Institutional Controls**

COST ESTIMATE SUMMARY

Site: Ventron/Velsicol Superfund Site
Media: Groundwater
Phase: OU 1 Feasibility Study
Base Year: 2005
Date: Rev 04/06/2006

Description: Institutional controls include Classification Exception Area. Confirmation groundwater sampling would be conducted every quarter for 2 years and then annually thereafter to assure that attenuation is occuring and that the plume is not moving.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$ 25,000	$ 25,000	CH2M Est.
TOTAL CAPITAL COST				**$ 25,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
Groundwater Monitoring						
Groundwater Samples		15	LS	$360	$5,400	CH2M Est.
QC Samples		5	LS	$360	$1,800	CH2M Est.
Groundwater Sampling, Level D						
Labor		48	HRS	$80	$3,840	CH2M Est. - 2 persons for 3 days
Equipment - meters		1	LS	$500	$500	CH2M Est.
Consumables		1	LS	$200	$200	CH2M Est.
Data Validation		4	HRS	$80	$320	CH2M Est.
Reporting		40	HRS	$80	$3,200	CH2M Est.
SUBTOTAL					$15,260	
Allowance for Misc. Items		20%			$3,052	
SUBTOTAL					$18,312	
Contingency		30%			$5,494	10% Scope + 20% Bid
SUBTOTAL					$23,806	
TOTAL ANNUAL O&M COST Year 0 to 2					**$95,000**	Quarterly for 2 years
TOTAL ANNUAL O&M COST Year 3 to 50					**$24,000**	Annual for Years 3 to 50

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
				Total	$150,000	
TOTAL ANNUAL PERIODIC COST					**$150,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$25,000	$25,000	1.00	$25,000	
ANNUAL O&M COST (Year 0-2)	0 to 2	$190,000	$95,000	1.81	$171,762	
ANNUAL O&M COST (Year 3-50)	3 to 50	$1,152,000	$24,000	13.80	$287,825	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$15,000	$15,000	0.51	$7,625	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$15,000	$15,000	0.26	$3,876	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
PERIODIC COST	30	$15,000	$15,000	0.13	$1,971	
PERIODIC COST	35	$15,000	$15,000	0.09	$1,405	
PERIODIC COST	40	$15,000	$15,000	0.07	$1,002	
PERIODIC COST	45	$15,000	$15,000	0.05	$714	
PERIODIC COST	50	$15,000	$15,000	0.03	$509	
		$1,517,000			$520,585	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$520,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: Groundwater Alternative G3 — **COST ESTIMATE SUMMARY**

Name: Hydraulic Controls via Pumping

Site: Ventron/Velsicol Superfund Site
Media: Groundwater
Phase: OU 1 Feasibility Study
Base Year: 2005
Date: Rev 04/06/2006

Description: Institutional controls include Classification Exception Area. Collect downgradient edge of the plume using 5 extraction wells and discharge effluent to POTW.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$25,000	$25,000	CH2M Est.
Predesign Investigations					
Pump Test	1	LS	$50,000	$50,000	CH2M Est.
Extraction Well Installation - 5 Total					
Site Setup and Submission of Workplans	1	LS	$25,000.00	$25,000	CH2M Est.
Soil Borings	100	FT	$46.50	$4,650	Miller Drilling Quotation
6-inch PVC Well Casing	50	FT	$24.61	$1,231	MEANS 33-23-0103
6-inch PVC Well Screen	50	FT	$44.42	$2,221	MEANS 33-23-0203
Trenching	3,000	LF	$30.00	$90,000	Project Exper
Conveyance Piping	3,000	LF	$12.00	$36,000	Project Exper
Pumps	5	EA	$4,220.78	$21,104	MEANS 33-23-0555
SUBTOTAL				$180,205	
Mobilization/Demobilization (Driller)	5%			$9,010	Miller Drilling Quotation
Subcontractor General Conditions (Driller)	15%			$27,031	Miller Drilling Quotation
SUBTOTAL				$216,246	
Treatment System					
Remediation Building w/ Electrical & HVAC	1	LS	$150,000	$150,000	CH2M Est.
GAC Unit	2	LS	$4,000	$8,000	US Filter Quotation
Tanks (Influent and Effluent)	2	LS	$6,160	$12,320	MEANS 33-10- 9659
Transfer Pumps	2	LS	$1,322	$2,645	MEANS 33-29-0101
Bag filters	2	LS	$800	$1,600	US Filter Quotation
System Installation	640	HRS	$80	$51,200	CH2M Est. - 4 people for one month
Startup - Labor	240	HRS	$80	$19,200	CH2M Est. - 2 persons for three weeks
Startup- Equipment	1	LS	$2,000	$2,000	CH2M Est.
Start-up- Consumables	1	LS	$1,000	$1,000	CH2M Est.
SUBTOTAL				$247,964	
Allowance for Misc. Items	20%			$49,593	
Fittings, Valves, Miscellaneous Appertanances	5%			$12,398	
Mobilization/Demobilization	5%			$12,398	
Subcontractor General Conditions	15%			$37,195	
SUBTOTAL				$359,548	
SUBTOTAL				$650,795	
Contingency	25%			$162,699	10% Scope + 15% Bid
SUBTOTAL				$813,494	
Project Management	5%			$40,675	**USEPA 2000, p. 5-13, $500K-$2M**
Remedial Design	12%			$97,619	**USEPA 2000, p. 5-13, $500K-$2M**
Construction Management	8%			$65,079	**USEPA 2000, p. 5-13, $500K-$2M**
SUBTOTAL				$203,373	
TOTAL CAPITAL COST				**$1,020,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
Groundwater Monitoring						
Groundwater Samples		15	LS	$360	$5,400	Contractor Estimate
QC Samples		5	LS	$360	$1,800	Contractor Estimate
Groundwater Sampling, Level D						
Labor		48	HRS	$80	$3,840	CH2M Est. - 2 persons, 3 days
Equipment - meters		1	LS	$500	$500	CH2M Est.
Consumables		1	LS	$200	$200	CH2M Est.
Data Validation		4	HRS	$80	$320	CH2M Est.
Reporting		40	HRS	$80	$3,200	CH2M Est.
SUBTOTAL					$15,260	
Allowance for Misc. Items		20%			$3,052	
SUBTOTAL					$18,312	
Contingency		30%			$5,494	10% Scope + 20% Bid
SUBTOTAL					$23,806	
Discharge to POTW						
Routine Operations, Maintenance, Monitoring		832	Hr	$80	$66,560	CH2M Est. - 2 days/week annually
Carbon Changeout		1	LS	$1,000	$1,000	Changeout Once each two years - 2 vessels (incl labor)
Carbon Changeour Mob Fee		0.5	LS	$300	$150	Once each 2 years
Carbon Disposal		0.5	LS	$250	$125	Assume Carbon is Non-Hazardous
Bag Filter Changeout		12	EA	$56	$672	Change 2 filters every 2 months
Treatment System Laboratory Analysis		12	EA	$360	$4,320	Contractor Estimate
Data Validation, Database Management		40	Hr	$80	$3,200	CH2M Est.
O&M Project Management		1	LS	$1,128	$1,128	15% of Sampling and Data Mgmt.
Electricity for System		12	Months	$400	$4,800	CH2M Est.
Reporting		1	LS	$20,000	$20,000	CH2M Est.
POTW Connection Fee		1	LS	$1,000	$1,000	BCUA (Metered Connection, with Engineering Fees)
POTW Annual Fees		10,512,000	GAL	$0.0015	$15,768	PVSC (Non-industrial WW with BOD & TSS < 500 mg/l)
Electricity For EW Pumps		16,337	KWH	$0.08	$1,269	MEANS 33-42-0101
SUBTOTAL					$119,992	
Contingency		30%			$35,998	10% Scope + 20% Bid
SUBTOTAL					$155,990	
TOTAL ANNUAL O&M COST Year 0 to 2					**$251,200**	GW Monitoring Quarterly for 2 years and Discharge to POTW
TOTAL ANNUAL O&M COST Year 3 to 50					**$179,800**	GW Monitoring Annually and Discharge to POTW

Alternative: **Groundwater Alternative G3** **COST ESTIMATE SUMMARY**
Name: **Hydraulic Controls via Pumping**

PERIODIC COSTS

DESCRIPTION	YEAR	QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
					$150,000	
TOTAL ANNUAL PERIODIC COST					**$150,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$1,020,000	$1,020,000	1.00	$1,020,000	
ANNUAL O&M COST (Year 0-2)	0 to 2	$502,400	$251,200	1.81	$454,174	
ANNUAL O&M COST (Year 3-50)	3 to 50	$8,630,400	$179,800	13.80	$2,156,293	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$15,000	$15,000	0.51	$7,625	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$15,000	$15,000	0.26	$3,876	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
PERIODIC COST	30	$15,000	$15,000	0.13	$1,971	
PERIODIC COST	35	$15,000	$15,000	0.09	$1,405	
PERIODIC COST	40	$15,000	$15,000	0.07	$1,002	
PERIODIC COST	45	$15,000	$15,000	0.05	$714	
PERIODIC COST	50	$15,000	$15,000	0.03	$509	
		$10,227,800			$3,666,464	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$3,670,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Groundwater Alternative G4** — **COST ESTIMATE SUMMARY**
Name: **Groundwater Pump and Treat**

Site: Ventron/Velsicol Superfund Site
Media: Groundwater
Phase: OU 1 Feasibility Study
Base Year: 2005
Date: Rev 04/06/2006

Description: Institutional controls include Classification Exception Area. Groundwater extraction collection with 7 extraction wells and treatment using a chemical ion exchange process with discharge of treated effluent to the POTW.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$25,000	$25,000	CH2M Est.
Predesign Investigations					
Bench Scale Pilot Testing	1	LS	$50,000	$50,000	CH2M Est.
Pilot Field Test	1	LS	$100,000	$100,000	CH2M Est.
Pump Test	1	LS	$50,000	$50,000	CH2M Est.
SUBTOTAL				$200,000	
Extraction Well Installation - 7 Total					
Site Setup and Submission of Workplans	1	LS	$25,000	$25,000	CH2M Est.
Soil Borings	140	FT	$47	$6,510	Miller Drilling Quotation
6-inch PVC Well Casing	70	FT	$25	$1,723	MEANS 33-23-0103
6-inch PVC Well Screen	70	FT	$44	$3,109	MEANS 33-23-0203
Trenching	4,250	LF	$30	$127,500	Project Exper
Conveyance Piping	4,250	LF	$12	$51,000	Project Exper
Pumps	7	EA	$4,221	$29,545	MEANS 33-23-0555
SUBTOTAL				$244,388	
Mobilization/Demobilization	5%			$12,219	Miller Drilling Quotation
Subcontractor General Conditions	15%			$36,658	Miller Drilling Quotation
SUBTOTAL				$293,265	
Treatment System					
Remediation Building w/ Electrical & HVAC	1	LS	$175,000	$175,000	Vendor Estimate
Greensand Filtration	1	EA	$40,000	$40,000	Vendor Estimate
GAC Units (4)	4	EA	$10,000	$40,000	2 units for primary, 2 units for backwash
Ion Exchange System	1	EA	$100,000	$100,000	Vendor Estimate
Ion Exchange Resin	160	CF	$1,250	$200,000	Vendor Estimate
Tanks (Influent and Effluent)	2	LS	$4,362.49	$8,725	MEANS 33-10- 9659
Potassium Permangante Feed Tank	1	EA	$2,000.00	$2,000	Vendor Estimate
Feed Pumps	1	EA	$1,500.00	$1,500	Vendor Estimate
Transfer Pumps	2	LS	$3,863.88	$7,728	MEANS 33-29-0120
System Installation	640	HRS	$80	$51,200	CH2M Est. - 4 people for one month
Startup - Labor	240	HRS	$80	$19,200	CH2M Est. - 2 persons for 3 weeks
Startup- Equipment	1	LS	$2,000	$2,000	CH2M Est.
Start-up- Consumables	1	LS	$1,000	$1,000	CH2M Est.
SUBTOTAL				$648,353	
Allowance for Misc. Items	20%			$129,670.55	
Fittings, Valves, Miscellaneous Appertananes	5%			$32,417.64	
Mobilization/Demobilization	5%			$32,417.64	
Subcontractor General Conditions	15%			$97,252.91	
SUBTOTAL				$940,111	
SUBTOTAL				$1,458,376	
Contingency	25%			$364,594	10% Scope + 15% Bid
SUBTOTAL				$1,822,971	
Project Management	6%			$109,378	**USEPA 2000, p. 5-13, $500K-$2M**
Remedial Design	12%			$218,756	**USEPA 2000, p. 5-13, $500K-$2M**
Construction Management	8%			$145,838	**USEPA 2000, p. 5-13, $500K-$2M**
SUBTOTAL				$473,972	
TOTAL CAPITAL COST				**$2,300,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
Annual GW Sampling						
Groundwater Samples		15	LS	$360	$5,400	Vocs and metals analysis
QC Samples		5	LS	$360	$1,800	Vocs and metals analysis
Groundwater Sampling, Level D						
Labor		48	HRS	$80	$3,840	CH2M Est. - 2 persons, 3 days
Equipment - meters		1	LS	$500	$500	CH2M Est.
Consumables		1	LS	$200	$200	CH2M Est.
Data Validation		4	HRS	$80	$320	CH2M Est.
Reporting		40	HRS	$80	$3,200	CH2M Est.
SUBTOTAL					$15,260	
Allowance for Misc. Items		20%			$3,052	
SUBTOTAL					$18,312	
Contingency		30%			$5,494	10% Scope + 20% Bid
SUBTOTAL					$23,806	
Treatment System						
Routine Operations, Maintenance, Monitoring		4,160	Hr	$80	$332,800	CH2M Est. - two FTE's
Treatment System Laboratory Analysis		24	EA	$360	$8,640	Contractor Estimate
Data Validation, Database Management		4	Hr	$80	$320	
O&M Project Management		1	LS	$1,344	$1,344	15% of Sampling and Data Mgmt.
Ion Exchange Resin Changeout		53	CF	$1,250	$66,250	One Changeout every three years
Greensand Filter Backwashing Labor		832	Hr	$80	$66,560	2 persons once a week

Alternative: Groundwater Alternative G4 — **COST ESTIMATE SUMMARY**

Name: Groundwater Pump and Treat

GAC Changeout	16	LS	$1,000	$16,000	Four times each year - 4 vessels
GAC Changeour Mob Fee	4	LS	$300	$1,200	4 times each year
GAC Disposal	4	LS	$250	$1,000	Assume Carbon is Non-Hazardous
Potassium Permangante Feed	500	LB	$2	$875	Envirox phone quote
Electricity	12	Months	$800	$9,600	CH2M Est.
Reporting	1	LS	$20,000	$20,000	CH2M Est.
POTW Connection Fee	1	LS	$1,000	$1,000	BCUA (Metered Connection w/ Engineering Fees)
POTW Annual Fees	15,768,000	GAL	$0.0015	$23,652	PVSC (BOD & TSS < 500 mg/L)
Electricity For EW Pumps	22,875	KWH	$0.08	$1,777	MEANS 33-42-0101
SUBTOTAL				$551,018	
Contingency	30%			$165,306	10% Scope + 20% Bid
SUBTOTAL				$716,324	
SUBTOTAL				$740,130	
TOTAL ANNUAL O&M COST				**$740,000**	

PERIODIC COSTS

DESCRIPTION		QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
SUBTOTAL					$75,000	
TOTAL ANNUAL PERIODIC COST					**$75,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$2,300,000	$2,300,000	1.000	$2,300,000	
ANNUAL O&M COST	1 to 25	$18,500,000	$740,000	11.65	$8,623,652	
PERIODIC COST	5	$15,000	$15,000	0.71	$10,695	
PERIODIC COST	10	$15,000	$15,000	0.51	$7,625	
PERIODIC COST	15	$15,000	$15,000	0.36	$5,437	
PERIODIC COST	20	$15,000	$15,000	0.26	$3,876	
PERIODIC COST	25	$15,000	$15,000	0.18	$2,764	
		$20,875,000			$10,954,048	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$10,950,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Groundwater Alternative G5** | **COST ESTIMATE SUMMARY**
Name: **Vertical Hydraulic Barrier**

Site: Ventron/Velsicol Superfund Site
Media: Groundwater
Phase: OU 1 Feasibility Study
Base Year: 2005
Date: Rev 04/06/2006

Description: Institutional controls include Classification Exception Area.
Installation of vertical hydraulic barrier, to bound highest mercury concentrations and limit downgradient extent.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$25,000.00	$25,000	CH2M Est.
Vertical Hydraulic Barrier Installation					
Site Setup and Submission of Workplans	1	LS	$25,000.00	$25,000	Includes submittals;
Install Slurry Wall (3 sides)	18,700	SF	$10.00	$187,000	Geo-Solutions Quote, 935 LF to 20' depth
Transport, Soil Stabilization/Disposal Off Site	468	TN	$370.00	$172,975	Top 4.5 foot hazardous, Treatment/Disposal to Emelle, AL (WMI Quote)
Clean Backfill	312	CY	$10.00	$3,117	CH2M Est.
Asphalt stabilized base course 2" thick	29	CY	$47.74	$1,378	Source 3; 5' wide x 935' length
Asphalt wearing course 2" thick	43	TN	$86.87	$3,760	MEANS
Install Sealed Sheetpile Wall Along Railroad (1 side)	7,500	SF	$32.20	$241,500	Waterloo Barrier Quote
Full TCLP Analysis	1	EA	$750.00	$750	1 samp/ 800 CY, Analytical Services Center Quote
Mobilization/Demobilization	1	LS	$100,000.00	$100,000	$50,000 for sheeting contractor, $50,000 for slurry wall contractor
SUBTOTAL				$735,480	
Subcontractor General Conditions	15%			$110,322	
SUBTOTAL				$845,802	
Contingency	25%			$211,450	10% Scope + 15% Bid
SUBTOTAL				$1,057,252	
Project Management	6%			$63,435	**USEPA 2000, p. 5-13, $500K-$2M**
Remedial Design	12%			$126,870	**USEPA 2000, p. 5-13, $500K-$2M**
Construction Management	8%			$84,580	**USEPA 2000, p. 5-13, $500K-$2M**
SUBTOTAL				$274,886	
TOTAL CAPITAL COST				**$1,360,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
Groundwater Sampling						
Groundwater Samples		15	LS	$360	$5,400	Contractor Estimate
QC Samples		5	LS	$360	$1,800	Contractor Estimate
Groundwater Sampling, Level D						
Labor		48	HRS	$80	$3,840	CH2M Est. - 2 persons, 3 days
Equipment - meters		1	LS	$500	$500	CH2M Est.
Consumables		1	LS	$200	$200	CH2M Est.
Data Validation		4	HRS	$80	$320	CH2M Est.
Reporting		40	HRS	$80	$3,200	CH2M Est.
SUBTOTAL					$15,260	
Allowance for Misc. Items		20%			$3,052	
SUBTOTAL					$18,312	
Contingency		30%			$5,494	10% Scope + 20% Bid
SUBTOTAL					$23,806	
TOTAL ANNUAL O&M COST Year 0 to 2					**$95,000**	Quarterly for 2 years
TOTAL ANNUAL O&M COST Year 3 to 50					**$24,000**	

PERIODIC COSTS

DESCRIPTION		QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
					$150,000	
TOTAL ANNUAL PERIODIC COST					**$150,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$1,360,000	$1,360,000	$1.00	$1,360,000	
ANNUAL O&M COST	1 to 2	$190,000	$95,000	$1.81	$171,762	
ANNUAL O&M COST - Annual Sampling	3 to 50	$1,152,000	$24,000	$13.80	$287,825	
PERIODIC COST	5	$15,000	$15,000	$0.71	$10,695	
PERIODIC COST	10	$15,000	$15,000	$0.51	$7,625	
PERIODIC COST	15	$15,000	$15,000	$0.36	$5,437	
PERIODIC COST	20	$15,000	$15,000	$0.26	$3,876	
PERIODIC COST	25	$15,000	$15,000	$0.18	$2,764	
PERIODIC COST	30	$15,000	$15,000	$0.13	$1,971	
PERIODIC COST	35	$15,000	$15,000	$0.09	$1,405	
PERIODIC COST	40	$15,000	$15,000	$0.07	$1,002	
PERIODIC COST	45	$15,000	$15,000	$0.05	$714	
PERIODIC COST	50	$15,000	$15,000	$0.03	$509	
		$2,852,000			$1,855,585	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$1,860,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Groundwater Alternative G6** — **COST ESTIMATE SUMMARY**
Name: **Vertical Hydraulic Barrier Around Site Perimeter**

Site: Ventron/Velsicol Superfund Site
Media: Groundwater
Phase: OU 1 Feasibility Study
Base Year: 2005
Date: Rev 04/06/2006

Description: Institutional controls include Classification Exception Area. Installation of vertical hydraulic barrier to bound perimeter of site and contain mercury-impacted soil. Hydraulic control within vertical hydraulic barrier.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Institutional Controls (Groundwater Use Restrictions)	1	LS	$25,000.00	$25,000	CH2M Est.
Vertical Hydraulic Barrier Installation					
Site Setup and Submission of Workplans	1	LS	$25,000.00	$25,000	Includes submittals;
Install Slurry Wall	95,400	SF	$10.00	$954,000	Geo-Solutions Quote, 20 foot depth
Soil Stabilization/Disposal Off Site	700	TN	$370.00	$259,000	Top 4.5' hazardous for 1400 LF, Disposal at Emelle, AL (WMI Quote)
Clean Backfill	467	CY	$10.00	$4,667	CH2M Est.
Asphalt stabilized base course 2" thick	37	CY	$47.74	$1,761	1195' length x 5' wide
Asphalt wearing course 2" thick	55	TN	$86.87	$4,806	
Install Sealed Sheetpile Wall Along Railroad	12,900	SF	$32.20	$415,380	Waterloo Barrier Quote (645 LF x 20 ft deep)
Full TCLP Analysis	1	EA	$750.00	$750	1 samp/ 800 CY, Analytical Services Center Quote
Mobilization/Demobilization	1	LS	$100,000.00	$100,000	$50,000 for sheeting contractor, $50,000 for slurry wall contractor
SUBTOTAL				$1,765,363	
Subcontractor General Conditions	15%			$264,805	
SUBTOTAL				$2,030,168	
Predesign Investigations					
Pump Test	1	LS	$50,000	$50,000	CH2M Est.
SUBTOTAL				$50,000	
Extraction Well Installation - 7 Total					
Site Setup and Submission of Workplans	1	LS	$25,000.00	$25,000	CH2M Est.
Soil Borings	140	FT	$46.50	$6,510	Miller Drilling Quotation
6-inch PVC Well Casing	70	FT	$24.61	$1,723	MEANS 33-23-0103
6-inch PVC Well Screen	70	FT	$44.42	$3,109	MEANS 33-23-0203
Trenching	6,000	LF	$30.00	$180,000	Project Exper
Conveyance Piping	6,000	LF	$12.00	$72,000	Project Exper
Pumps	7	EA	$4,220.78	$29,545	MEANS 33-23-0555
SUBTOTAL				$317,888	
Mobilization/Demobilization (Driller)	5%			$15,894	Miller Drilling Quotation
Subcontractor General Conditions (Driller)	15%			$47,683	Miller Drilling Quotation
SUBTOTAL				$381,465	
Treatment System					
Remediation Building w/ Electrical & HVAC	1	LS	$150,000	$150,000	CH2M Est.
GAC Unit	2	LS	$4,000	$8,000	US Filter Quotation
Tanks (Influent and Effluent)	2	LS	$6,160	$12,320	MEANS 33-10- 9659
Transfer Pumps	2	LS	$1,322	$2,645	MEANS 33-29-0101
Bag filters	2	LS	$800	$1,600	US Filter Quotation
System Installation	640	HRS	$80	$51,200	CH2M Est. - 4 people for one month
Startup - Labor	240	HRS	$80	$19,200	CH2M Est. - 2 persons for three weeks
Startup- Equipment	1	LS	$2,000	$2,000	CH2M Est.
Start-up- Consumables	1	LS	$1,000	$1,000	CH2M Est.
SUBTOTAL				$247,964	
Allowance for Misc. Items	20%			$49,593	
Fittings, Valves, Miscellaneous Appertanances	5%			$12,398	
Mobilization/Demobilization	5%			$12,398	
Subcontractor General Conditions	15%			$37,195	
SUBTOTAL				$359,548	
SUBTOTAL				$2,846,181	
Contingency	25%			$711,545	10% Scope + 15% Bid
SUBTOTAL				$3,557,727	
Project Management	5%			$177,886	**USEPA 2000, p. 5-13, $2M - $10M**
Remedial Design	8%			$284,618	**USEPA 2000, p. 5-13, $2M - $10M**
Construction Management	6%			$213,464	**USEPA 2000, p. 5-13, $2M - $10M**
SUBTOTAL				$675,968	
TOTAL CAPITAL COST				**$4,230,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	YEAR	QTY	UNIT	COST	TOTAL	NOTES
Groundwater Sampling						
Groundwater Samples		15	LS	$360	$5,400	Contractor Estimate
QC Samples		5	LS	$360	$1,800	Contractor Estimate
Groundwater Sampling, Level D						
Labor		48	HRS	$80	$3,840	CH2M Est. - 2 persons, 3 days
Equipment - meters		1	LS	$500	$500	CH2M Est.
Consumables		1	LS	$200	$200	CH2M Est.
Data Validation		4	HRS	$80	$320	CH2M Est.
Reporting		40	HRS	$80	$3,200	CH2M Est.
SUBTOTAL					$15,260	
Allowance for Misc. Items		20%			$3,052	
SUBTOTAL					$18,312	
Contingency		30%			$5,494	10% Scope + 20% Bid
SUBTOTAL					$23,806	
Discharge to POTW						
Routine Operations, Maintenance, Monitoring		832	Hr	$80	$66,560	CH2M Est. - 2 days/week annually
Carbon Changeout		1	LS	$1,000	$1,000	Changeout Once each two years - 2 vessels (incl labor)
Carbon Changeout Mob Fee		0.5	LS	$300	$150	Once each 2 years
Carbon Disposal		0.5	LS	$250	$125	Assume Carbon is Non-Hazardous
Bag Filter Changeout		24	LS	$56	$1,344	Change 2 filters every 2
Treatment System Laboratory Analysis		12	EA	$360	$4,320	Contractor Estimate
Data Validation, Database Management		40	Hr	$80	$3,200	CH2M Est.
O&M Project Management		1	LS	$1,128	$1,128	15% of Sampling and Data Mgmt.
Electricity for System		12	Months	$400	$4,800	CH2M Est.

Alternative: **Groundwater Alternative G6** **COST ESTIMATE SUMMARY**

Name: **Vertical Hydraulic Barrier Around Site Perimeter**

Reporting	1	LS	$20,000	$20,000	CH2M Est.
POTW Connection Fee	1	LS	$1,000	$1,000	BCUA (Metered Connection, with Engineering Fees)
POTW Annual Fees	3,530,000	GAL	$0.0015	$5,295	PVSC (Non-industrial WW with BOD & TSS < 500 mg/l)
Electricity For EW Pumps	2,287	KWH	$0.08	$178	MEANS 33-42-0101
SUBTOTAL				$109,100	
Contingency	30%			$32,730	10% Scope + 20% Bid
SUBTOTAL				$141,830	
TOTAL ANNUAL O&M COST Year 0 to 2				**$237,000**	Quarterly for 2 years + Treatment & Discharge to POTW
TOTAL ANNUAL O&M COST Year 3 to 50				**$166,000**	Annual GW + Treatment & Discharge to POTW

PERIODIC COSTS

DESCRIPTION		QTY	UNIT	UNIT COST	TOTAL	NOTES
5 year Review	5	1	LS	$15,000	$15,000	
5 year Review	10	1	LS	$15,000	$15,000	
5 year Review	15	1	LS	$15,000	$15,000	
5 year Review	20	1	LS	$15,000	$15,000	
5 year Review	25	1	LS	$15,000	$15,000	
5 year Review	30	1	LS	$15,000	$15,000	
5 year Review	35	1	LS	$15,000	$15,000	
5 year Review	40	1	LS	$15,000	$15,000	
5 year Review	45	1	LS	$15,000	$15,000	
5 year Review	50	1	LS	$15,000	$15,000	
					$150,000	
TOTAL ANNUAL PERIODIC COST					**$150,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 7.0%

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
CAPITAL COST	0	$4,230,000	$4,230,000	$1.00	$4,230,000	
ANNUAL O&M COST	1 to 2	$474,000	$237,000	$1.81	$428,500	
ANNUAL O&M COST - Annual Sampling	3 to 50	$7,968,000	$166,000	$13.80	$1,990,793	
PERIODIC COST	5	$15,000	$15,000	$0.71	$10,695	
PERIODIC COST	10	$15,000	$15,000	$0.51	$7,625	
PERIODIC COST	15	$15,000	$15,000	$0.36	$5,437	
PERIODIC COST	20	$15,000	$15,000	$0.26	$3,876	
PERIODIC COST	25	$15,000	$15,000	$0.18	$2,764	
PERIODIC COST	30	$15,000	$15,000	$0.13	$1,971	
PERIODIC COST	35	$15,000	$15,000	$0.09	$1,405	
PERIODIC COST	40	$15,000	$15,000	$0.07	$1,002	
PERIODIC COST	45	$15,000	$15,000	$0.05	$714	
PERIODIC COST	50	$15,000	$15,000	$0.03	$509	
		$12,822,000			$6,685,290	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$6,690,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Appendix D

Ion Exchange Vendor Information

AMBERLITE® GT73

Industrial Grade Complexing Resin

PRODUCT DATA SHEET

AMBERLITE GT73 is a weakly acidic cation exchange resin with very pronounced selectivity for certain metal ions, e.g. rhodium, copper, silver, cadmium and lead.
AMBERLITE GT73 has been developed for the removal of Hg from different solutions and gaseous streams and can be regenerated very efficiently with hydrochloric acid.

The selectivity sequence is :
Hg > Ag > Cu > Pb > Cd > Ni > Co > Fe > Ca > Na.

AMBERLITE GT73 is insoluble in common solvents and stable over the entire pH range. Oxidizing media should be avoided. The special properties of AMBERLITE GT73 can be useful for problems where removal of metal ions Cu, Ag, Pb, Cd is desired. Applications may be found in different fields of chemical technology such as waste water treatment, recovery of solutions and metals in the plating industry, reocovery of catalysts and removal of interfering ions in hydrometallurgy.

PROPERTIES

Matrix	Macroporous styrene copolymer
Functional groups	Thiol
Physical form	Beads
Ionic form as shipped	H
Total exchange capacity [1]	≥ 1.20 eq/L (H form)
Moisture holding capacity [1]	50 to 56 % (H form)
Shipping weight	785 g/L (49.0 lb/ft^3)
Particle size	
Harmonic mean size	0.450 - 0.700 mm
Uniformity coefficient	≤ 1.9
Fines content [1]	< 0.425 mm : 12 % max
Coarse beads	> 0.850 mm : 25 % max

[1] *Contractual value*
Test methods available upon request

SUGGESTED OPERATING CONDITIONS

Maximum operating temperature	60°C (140 °F)
Minimum bed depth	1 m (39 inches)
Service flow rate	10 BV/h (1.25 gpm/ft^3)
Regenerant	Concentrated hydrochloric acid
Rinse requirements	2 to 3 BV* (15 to 22.5 gal/ft^3)
Backwash flow rate	About 12 m/h (5 gpm/ft^2) with water at 20°C (68 °F)

* *1 BV (Bed Volume) = 1 m^3 solution per m^3 resin*

SELECTIVITY

The high selectivity of AMBERLITE GT73 for certain metals is shown in the graph below as a function of pH. All data were determined in a normal solution of $NaNO_3$. The resin has a pronounced preference for copper, lead and cadmium ions, which are removed in considerable quantities, even from solutions containing only 1 meq/L of metal and a large excess of Na^+ ions. The data indicate the possibility of selective separation of these metals.

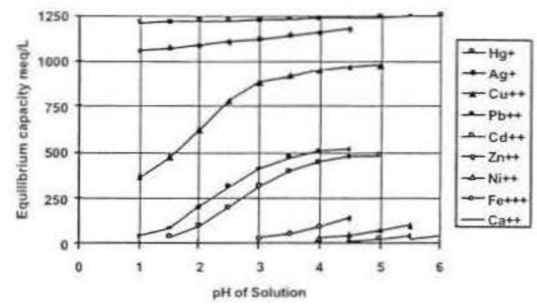
Example : Removal of lead from waste water

Influent composition

• Pb^{++}	6 ppm
• Sb^{+++}	0.3 ppm
• Na^+	100 ppm
• pH	2.5

The solution passes a column of AMBERLITE GT73 at a flow rate of 15 m/h (6 gpm/ft^2). The effluent contains less than 0.01 ppm Pb. . After passage of 700 bed volumes of the solution the effluent composition was still unchanged.

DUOLITE GT73
Equilibrium Capacities



All our products are produced in ISO 9002 certified manufacturing facilities.

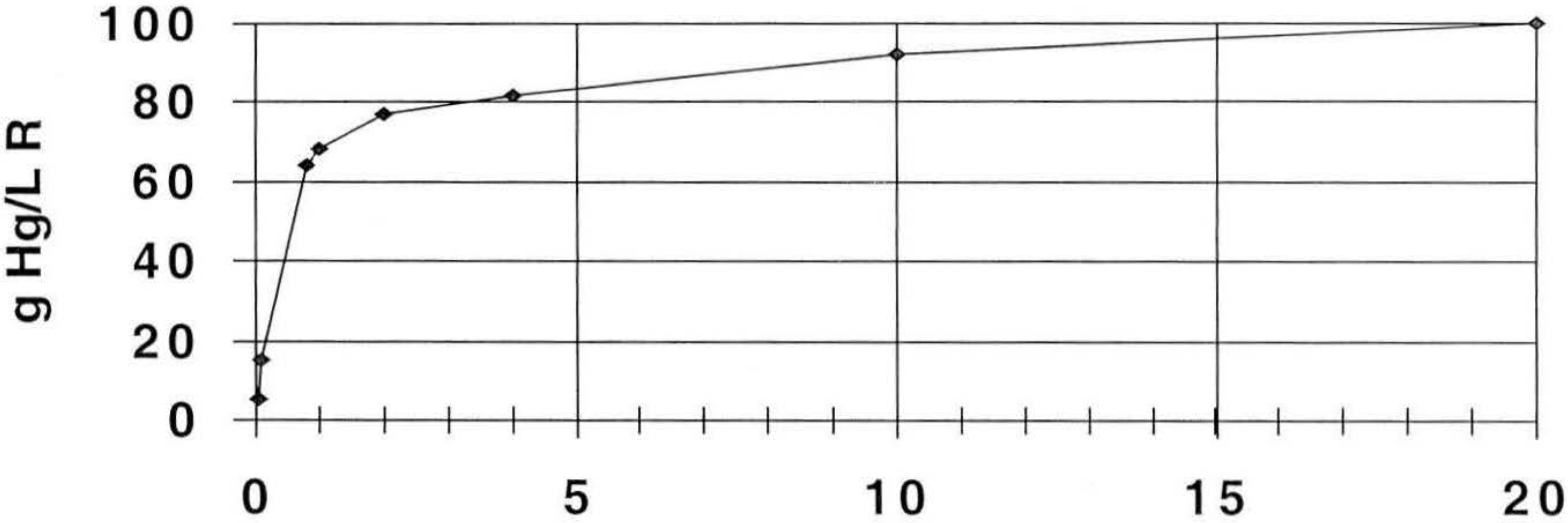
Rohm and Haas/Ion Exchange Resins - Philadelphia, PA - Tel. (800) RH AMBER - Fax: (215) 409-4534
Rohm and Haas/Ion Exchange Resins - 75579 Paris Cedex 12 - Tel. (33) 1 40 02 50 00 - Fax : 1 43 45 28 19

WEB SITE: http://www.rohmhaas.com/ionexchange

Ion exchange resins and polymeric adsorbents, as produced, contain by-products resulting from the manufacturing process. The user must determine the extent to which organic by-products must be removed for any particular use and establish techniques to assure that the appropriate level of purity is achieved for that use. The user must ensure compliance with all prudent safety standards and regulatory requirements governing the application. Except where specifically otherwise stated, Rohm and Haas Company does not recommend its ion exchange resins or polymeric adsorbents, as supplied, as being suitable or appropriately pure for any particular use. Consult your Rohm and Haas technical representative for further information. Acidic and basic regenerant solutions are corrosive and should be handled in a manner that will prevent eye and skin contact. Nitric acid and other strong oxidising agents can cause explosive type reactions when mixed with Ion Exchange resins. Proper design of process equipment to prevent rapid buildup of pressure is necessary if use of an oxidising agent such as nitric acid is contemplated. Before using strong oxidising agents in contact with Ion Exchange Resins, consult sources knowledgeable in the handling of these materials.

Amberlite GT73

Equilibrium capacities



Revised: 25 March 2004

Appendix E

Acceptance Letters of Deed Notices by Property Owners

OFFICE OF THE CUSTODIAL TRUST
LePETOMANE III, INC., NOT INDIVIDUALLY
BUT SOLELY AS CUSTODIAL TRUST TRUSTEE
321 NORTH CLARK STREET • SUITE 2700 • CHICAGO, IL 60611
Phone: (312) 337-2688
Fax: (312) 337-1766
Custodialtrust@lepetomaneinctrustee.com

May 13, 2005

Margaret Lattin Bazany
Senior Counsel
Rohm and Haas Company
100 Independence Mall West
Philadelphia, PA 19106-2399

RE: Remediation of Wood-Ridge Superfund Site

Dear Ms. Bazany:

This will respond to your recent request concerning our willingness to indicate whether the Custodial Trust, by and through LePetomane III, Inc., not individually but solely in the representative capacity of Custodial Trustee under the Custodial Trust Agreement dated August 19, 2002 ("Custodial Trust"), would consent to the recordation of a deed notice for the property owned by it in the Boroughs of Wood-Ridge and Carlstadt, Bergen County in connection with the remediation by Morton International, Inc. ("Morton") and the Custodial Trust of the Wood-Ridge Superfund Site.

We understand that a deed notice is used in New Jersey whenever soils at a property are remediated to a non-residential cleanup standard or an engineering or institutional control is used as part of a soils remedy. In this instance we understand that soils in certain areas of the Custodial Trust's property contain mercury in excess of remediation standards, and that Morton intends to propose to the New Jersey Department of Environmental Protection (NJDEP) to remediate those soils by covering them with an engineered asphalt cap as an exposure barrier.

You have provided us with a copy of the form deed notice used by NJDEP which describes the types of information concerning the contamination and remedy required to be included in the deed notice.

In light of the above, this is to advise you that the Custodial Trust will consider executing a deed notice that is approved by the Custodial Trust and the NJDEP. Any deed notice would also state that any requirements, obligations and or limitations imposed upon the Custodial Trust would be consistent with and subject to the requirements, obligations and or limitations as contained in the Bankruptcy Settlement Agreement as approved by the United States Bankruptcy Court on August 9, 2002 (the "Agreement"). In addition, any funds required by the Custodial Trust for compliance with the Deed Notice will be paid consistent with the Agreement. Any such payment by the Custodial Trust would be from the Wood-Ridge Site Subaccount.

Sincerely,

Office of the Custodial Trust
LePetomane, III, Inc., Not individually
but solely in the representative capacity
of Custodial Trust Trustee

Not individually but solely as President

BY: Jay A. Steinberg
Jay A. Steinberg, Not individually but
solely in the representative capacity of
President of LePetomane III, Inc., not
individually but solely in the representative
capacity of Custodial Trust Trustee

COLE, SCHOTZ, MEISEL, FORMAN & LEONARD, P.A.

A PROFESSIONAL CORPORATION

COUNSELLORS AT LAW

COURT PLAZA NORTH

25 MAIN STREET

P.O. BOX 800

HACKENSACK, NEW JERSEY 07602-0800

(201) 489-3000

FAX (201) 489-1536

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telecommunication device for the deaf
(201) 489-3479

767 THIRD AVENUE

NEW YORK, NEW YORK 10017

(212) 752-0110
FAX (212) 751-8238

REPLY TO HACKENSACK OFFICE

WRITER'S DIRECT LINE:
(201) 525-6245

WRITER'S DIRECT FACSIMILE:
(201) 678-6245

WRITER'S EMAIL ADDRESS:
gduus@coleschotz.com

May 16, 2005

Via E-mail
Margaret L. Bazany
Senior Counsel
Rohm and Haas Company
100 Independence Mall West
Philadelphia, PA 19106-2399

RE: Remediation of Wood-Ridge Superfund Site
Jerbil, Inc. premises: Lot 10.01 in Block 229 on Wood Ridge tax map
EJB, Inc. premises: Lot 11 in Block 229.01 on Wood Ridge tax map

Dear Ms. Bazany:

This firm represents both Jerbil, Inc. and EJB, Inc. with regard to your recent request concerning their willingness to consent to the recordation of a deed notice for their referenced respective properties in connection with the remediation of the Wood-Ridge Superfund Site. My clients willingness to do so is conditioned upon having their issues, as discussed in this letter, satisfactorily addressed. Only if those conditions are met will my clients be willing to consent to the recordation of a deed notice.

You have indicated that the remediation is being performed by Morton International, Inc. and the Custodial Trust, by and through LePetomane III, Inc., not individually but solely in the representative capacity of Custodial Trustee under the Custodial Trust Agreement dated August 19, 2002 ("Custodial Trust"). We need to understand the role of Rohm and Haas in the remediation and whether Rohm and Haas is the party which will be responsible for addressing my client's concerns, or whether there will be involvement by Morton International, Inc. (as I understand it a subsidiary of Rohm and Haas), the Custodial Trust, or other parties.

We understand that a deed notice is used in New Jersey whenever soils at a property are remedied using an engineering control. In this instance, we understand from you that soils in certain areas of the referenced properties of Jerbil Inc. and EJB, Inc. contain mercury in excess of non-residential soil remediation standards, and that Morton International and the Custodial Trust intend to propose to the New Jersey Department of Environmental Protection (NJDEP) to remedy those soils by covering them with an engineered asphalt cap as an exposure barrier. In light of the use of this engineering control remedy, you have indicated that Morton International and the Custodial Trust intend to propose that a deed notice be recorded for the property describing the location of the contaminants, the nature and location of the engineered cap and other matters required to be addressed in the deed notice. You have provided us with a copy of the form deed notice used by NJDEP that you propose to use for my clients' properties which sets forth the matters to be addressed.

My clients would like the following to be addressed prior to their giving consent to the use of a deed notice:

1. My clients will expect to be compensated for accepting a deed notice, as clearly the deed notice will affect the value of their properties and their ability to be sold, leased or used as collateral for a loan.

2. My clients will need to approve the remedial design for the soil on their respective properties. There would need to be an agreement as to the long term maintenance of any cap on contamination. My clients would expect Rohm and Haas entities to be liable for any long term maintenance other than routine maintenance.

3. You have indicated your client's interest in the design and construction of certain drainage improvements on the properties. My clients will need to approve the design and construction of such improvements.

4. My clients need to understand and approve the groundwater remedial approach for their properties and for any contamination which may migrate onto their properties. My clients paramount concern is that the contamination not interfere with the use of the properties.

5. We would need to negotiate access provisions to address the manner in which the work would be performed. For example, performing the work on nights and weekends to avoid interfering with on-site operations.

6. My clients would expect a broad indemnity for any liability or loss arising from any contamination which has been or remains on their properties. This would include third party claims for property damage, bodily injury or business interruption.

7. Depending upon the sophistication of the issues raised by your proposal, my clients may require that Rohm & Haas reimburse them for reasonable consulting and attorney's fees.

This list is not intended to be exhaustive, as other issues may arise as the details of the above are addressed. While my clients will consider a deed notice as an engineering control remedy, they will not consent to any deed notice unless and until an agreement, acceptable to my clients, which addresses all issues is negotiated and executed by the parties.

Should you have any questions, or wish to discuss this matter, please do not hesitate to contact me.

Very truly yours,

/s/Gordon C. Duus

Gordon C. Duus

cc: Jerry Rosenblum
William Rosenblum
Jeffrey H. Schechter, Esq.
Carl A. Rizzo, Esq.

WILENTZ GOLDMAN &SPITZER P.A.

ATTORNEYS AT LAW

90 Woodbridge Center Drive
Suite 900 Box 10
Woodbridge, NJ 07095-0958
(732) 636-8000
Fax (732) 855-6117

Meridian Center I
Two Industrial Way West
Eatontown, NJ 07724-2265
(732) 542-4500
Fax (732) 493-8387

Wall Street Plaza
88 Pine Street
New York, NY 10005-1801
(212) 267-3091
Fax (212) 267-3828

1705 Two Penn Center Plaza
Philadelphia, PA 19102
(215) 567-0500
Fax (215) 567-0700

http://www.wilentz.com

Please reply to
Woodbridge
(732) 855-6121 Direct Dial
(732) 726-6566 Direct Fax

May 19, 2005

RECEIVED
MAY 2 3 2005

VIA FACSIMILE (484-430-5711) AND U.S. MAIL

Bruce S. Katcher, Esq.
Manko, Gold, Katcher & Fox
401 City Avenue
Suite 500
Bala Cynwyd, Pennsylvania 19004

Re: Julius Blum & Co., Inc. – Rohm and Haas Company
Proposed Deed Notice
Lot 1, Block 229, Borough of Wood-Ridge, Bergen County, New Jersey

Dear Mr. Katcher:

Please be advised that this firm represents Julius Blum & Co., Inc. ("JBC"), the owner of the above-referenced property. JBC has authorized the undersigned to send this letter advising that JBC is willing to consider executing a deed notice for a portion of its property, subject to continued discussions with Rohm and Haas Company ("RHC") regarding the terms pursuant to which JBC would execute such a deed notice, which shall include, but not be limited to, JBC and RHC's reaching an understanding with respect to the issues raised by JBC concerning the completion of the deed notice form and its execution. It should be noted that, to date, a completed deed notice has not been presented to JBC for review.

Should you have any questions or concerns, please do not hesitate to contact me.

Very truly yours,

Elizabeth W. Eaton

ELIZABETH W. EATON

EWE/df

cc: Ms. Joanne Blum
Francis X. Journick, Jr., Esq.
Douglas Watson Lubic, Esq.

JRMA Holding, L.L.C.

472 Barell Avenue
Carlstadt, N.J. 07072
201 507 0700
201 507 0708 Fax

Margaret Lattin Bazany
Senior Counsel
Rohm and Haas Company
100 Independence Mall West
Philadelphia, PA 19106-2399

RE: Remediation of Wood-Ridge Superfund Site

Dear Ms. Bazany:

This will respond to your recent request concerning the willingness of me and my wife to consent to the recordation of a deed notice for the property owned by us in the Borough of Wood-Ridge, Bergen County, Tax Block 229, Lot 10.02 in connection with the remediation of the Wood-Ridge Superfund Site by Morton International, Inc.("Morton"), a wholly owned subsidiary of Rohm and Haas Company, and the Custodial Trust, by and through LePetomane III, Inc., not individually but solely in the representative capacity of Custodial Trustee under the Custodial Trust Agreement dated August 19, 2002 ("Custodial Trust").

We understand that a deed notice is used in New Jersey whenever soils at a property are remediated using an engineering or institutional control. In this instance, we understand that soils in certain areas of our property contain mercury in excess of non-residential soil remediation standards, and that Morton International and the Custodial Trust intend to propose to the New Jersey Department of Environmental Protection (NJDEP) to remediate those soils by covering them with an engineered asphalt cap as an exposure barrier. In light of the use of this engineering control remedy, Morton and the Custodial Trust intend to propose that a deed notice be recorded for the property describing the location of the contaminants, the nature and location of the engineered cap and other matters required to be addressed in the deed notice. You have provided us with a copy of the form deed notice used by NJDEP that you propose to use for our property which sets forth the matters to be addressed.

In light of the above, this is to advise you that we will consider a deed notice for an engineering control remedy, contingent on satisfactory resolution of issues relating to the remedy and the property prior to filing of the deed notice.

Sincerely,

Jonathan Blonde

Borough of Wood-Ridge

PAUL A. SARLO
Mayor

NICHOLAS FARGO
Administrator/CFO

DIANE THORNLEY, RMC/CMC
Borough Clerk

PAUL S. BARBIRE
Borough Attorney

MUNICIPAL BUILDING
85 HUMBOLDT STREET
WOOD-RIDGE, NJ 07075-2396
TEL: (201) 939-0202 FAX: (201) 939-1215
Web site: www.wood-ridgenj.org

COUNCIL:
CATHERINE CASSIDY
Council President

THOMAS C. GONNELLA
EDWARD H. PFEIFER
ROBERT RICCARDELLA
RICHARD CARBONARO
EZIO I. ALTAMURA

RECEIVED
MAY 16 2005

May 10, 2005

Margaret L. Bazany
Senior Counsel
Rohm and Haas Company
100 Independence Mall West
Philadelphia, PA 19106-2399

RE: Remediation of Wood-Ridge Superfund Site

Dear Ms. Bazany:

This will respond to your recent request concerning the Borough of Wood-Ridge's willingness to consent to the recordation of a deed notice for the property owned by it in the Borough of Wood-Ridge consisting of Ethel Boulevard in connection with the remediation of the Wood-Ridge Superfund Site by Morton International, Inc. and the Custodial Trust, by and through LePetomane III, Inc., not individually but solely in the representative capacity of Custodial Trustee under the Custodial Trust Agreement dated August 19, 2002 ("Custodial Trust").

We understand that a deed notice is used in New Jersey whenever soils at a property are remediated to a non-residential cleanup standard or an engineering or institutional control is used as part of a soils remedy. In this instance we understand that soils in certain areas of Ethel Boulevard contain mercury in excess of non-residential soil remediation standards, and that Morton International and the Custodial Trust have proposed to the New Jersey Department of Environmental Protection (NJDEP) to remediate those soils by covering them with an engineered asphalt cap as an exposure barrier. In light of the use of this engineering control remedy, Morton International and the Custodial Trust have proposed that a deed notice be recorded for the property describing the location of the contaminants, the nature and location of the engineered cap and other matters required to be addressed in the deed notice. You have provided us with a copy of the form deed notice used by NJDEP that you propose to use for the Ethel Boulevard property which sets forth the matters to be addressed.

In light of the above, this is to advise you that the Borough of Wood-Ridge will consider a deed notice for an engineering control remedy, contingent on satisfactory resolution of issues relating to the remedy and the property are reached prior to recording of the deed notice.

Sincerely,

Mayor
Borough of Wood-Ridge

1656th REGULAR MEETING, MAY 10, 2005

RESOLUTION NO.: I

WHEREAS, the Borough of Wood-Ridge has been requested by counsel for Rohm and Haas Company to indicate its willingness to consider a Deed Notice for premises owned by the Borough and known as Ethel Boulevard; and

WHEREAS, the within action is of a non-binding nature at this junction and the Borough may in the future modify its position for any appropriate reason whatsoever; and

WHEREAS, the within request by Rohm and Haas Company is made in conjunction with the remediation of the Wood-Ridge Superfund Site and in accordance with the requirements of the New Jersey Department of Environmental Protection.

NOW, THEREFORE, BE IT RESOLVED by the Mayor and Council of the Borough of Wood-Ridge, County of Bergen, State of New Jersey as follows:

1. The Mayor, Clerk, Borough Attorney and/or any other appropriate official are hereby authorized to execute the form of letter attached hereto and made a part hereof subject to the specific provisions of this resolution document.

Paul A Sarlo

PAUL A. SARLO
MAYOR

Diane Thornley

DIANE THORNLEY
BOROUGH CLERK

CERTIFIED to be a true copy of a Resolution adopted by the Mayor and Council of the Borough of Wood-Ridge, N.J. at a regular meeting

HELD ON May 10, 2005

MUNICIPAL CLERK Diane Thornley

Norfolk Southern Corporation
Law Department
Three Commercial Place
Norfolk, Virginia 23510-9241

Karin L. Stamy
General Attorney

Writer's Direct Dial Number

(757) 629-2752
(757) 823-5794 (fax)
email: klstamy@nscorp.com

May 12, 2005

Margaret Lattin Bazany
Senior Counsel
Rohm and Haas Company
100 Independence Mall West
Philadelphia, PA 19106-2399

Re: Remediation of Wood-Ridge Superfund Site

Dear Ms. Bazany:

This will respond to your recent request concerning our willingness to indicate whether Norfolk Southern Railway Company ("NSR") would consent to the recordation of a deed notice for the property owned by it in the Borough of Wood-Ridge, Bergen County in connection with the remediation by Morton International, Inc. and the Custodial Trust, by and through LePetomane III, Inc., not individually but solely in the representative capacity of Custodial Trustee under the Custodial Trust Agreement dated August 19, 2002 ("Custodial Trust"), of the Wood-Ridge Superfund Site.

I understand that a deed notice is used in New Jersey whenever soils at a property are remediated to a non-residential cleanup standard or an engineering or institutional control is used as part of a soils remedy. In this instance I understand that soils in certain areas of NSR's property contain mercury in excess of non-residential soil remediation standards, and that Morton and the Custodial Trust intend to propose to the New Jersey Department of Environmental Protection (NJDEP) to remediate those soils by maintaining an engineered cap as an exposure barrier. I understand that, in light of the use of this engineering control remedy, Morton and the Custodial Trust intend to propose that a deed notice be recorded for the property describing the location of the contaminants, the nature and location of the engineered cap and other matters required to be addressed in the deed notice. You have provided us with a copy of the form deed notice used by NJDEP.

In light of the above, this is to advise you that NSR will consider a deed notice for an engineering control remedy, provided that acceptable resolution of NSR's concerns relating to the remedy, the property, and rail maintenance, operation, construction and safety is achieved prior to filing of the deed notice.

Very truly yours,

Karin L. Stamy

:kls

President Container Group

200 West Commercial Ave. • Moonachie, New Jersey • 07074
Phone: NJ 201-933-7500 • Fax 201-933-8990 • NY 212-244-0345
Mailing Address: P.O. Box 387, Wood-Ridge, NJ 07075-0387
www.pcgpop.com

February 3, 2006

Margaret Latin Bazany
Senior Counsel
Rohm and Haas Company
100 Independence Mall West
Philadelphia, PA 19106

Re: Prince Packaging Inc. Property, Wood-Ridge, NJ - Deed Notice

Dear Ms. Bazany:

This is to advise you that Prince Packaging, Inc. is willing to consider recording a deed notice for the property it owns in the Borough of Wood-Ridge, Bergen County, Block 229, Lot 2 in connection with the remediation by Morton International, Inc. of the Wood-Ridge Superfund Site. When we first discussed this subject at our meeting in my office several months ago, you indicated that the final details of the deed notice would be worked out when the New Jersey Department of Environmental Protection was ready to issue its record of decision describing the remedy. I understand that the Department is in the process of finalizing its decision and that you will make arrangements to meet with me to review the final form of deed notice within the next few weeks to work out the final details. Our willingness to consider recording the deed notice is subject to the satisfactory conclusion of these additional discussions.

Sincerely,

Marvin Berger, Vice President
Prince Packaging Inc.

Figures

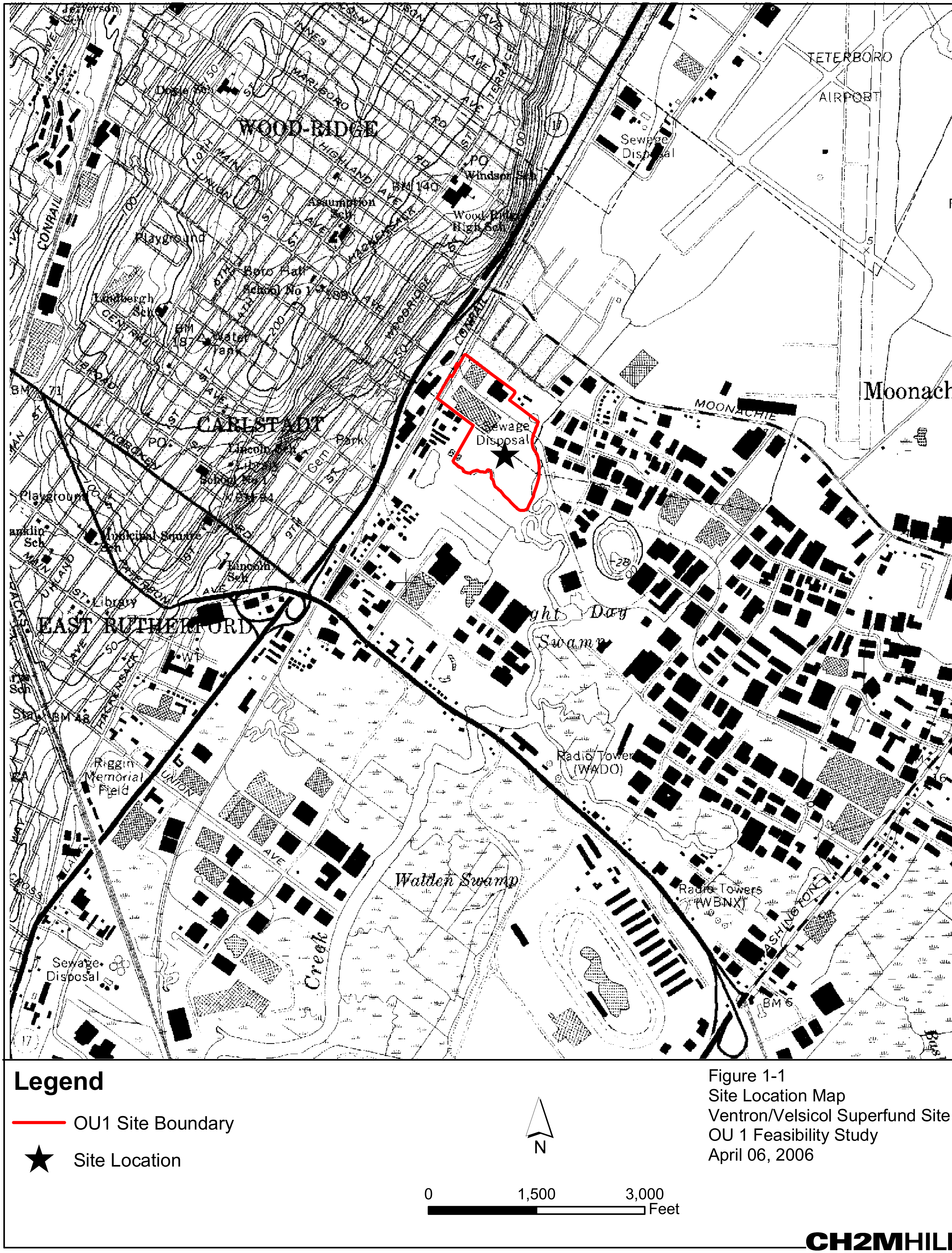


Figure 1-1
Site Location Map
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL

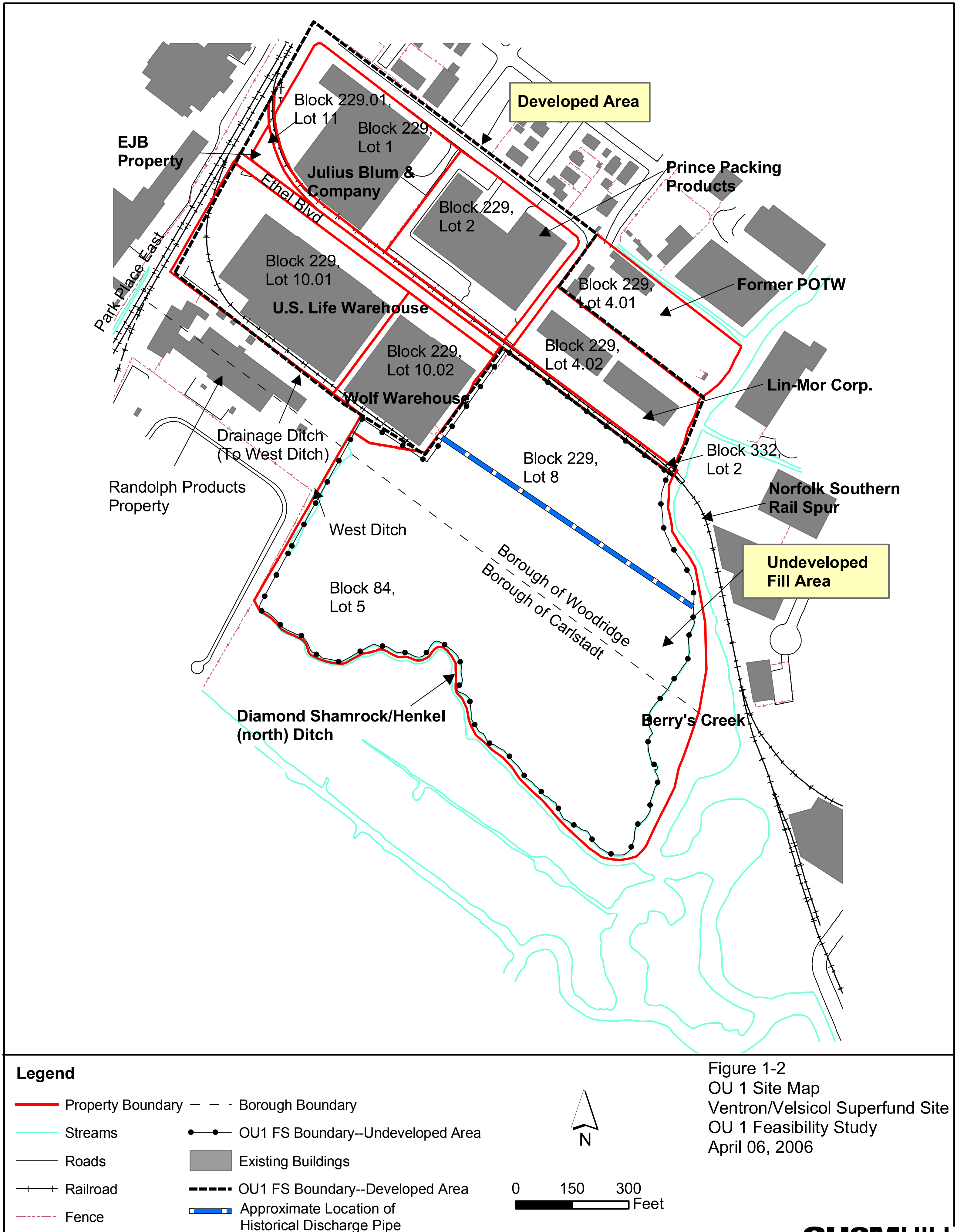


Figure 1-2
OU 1 Site Map
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL

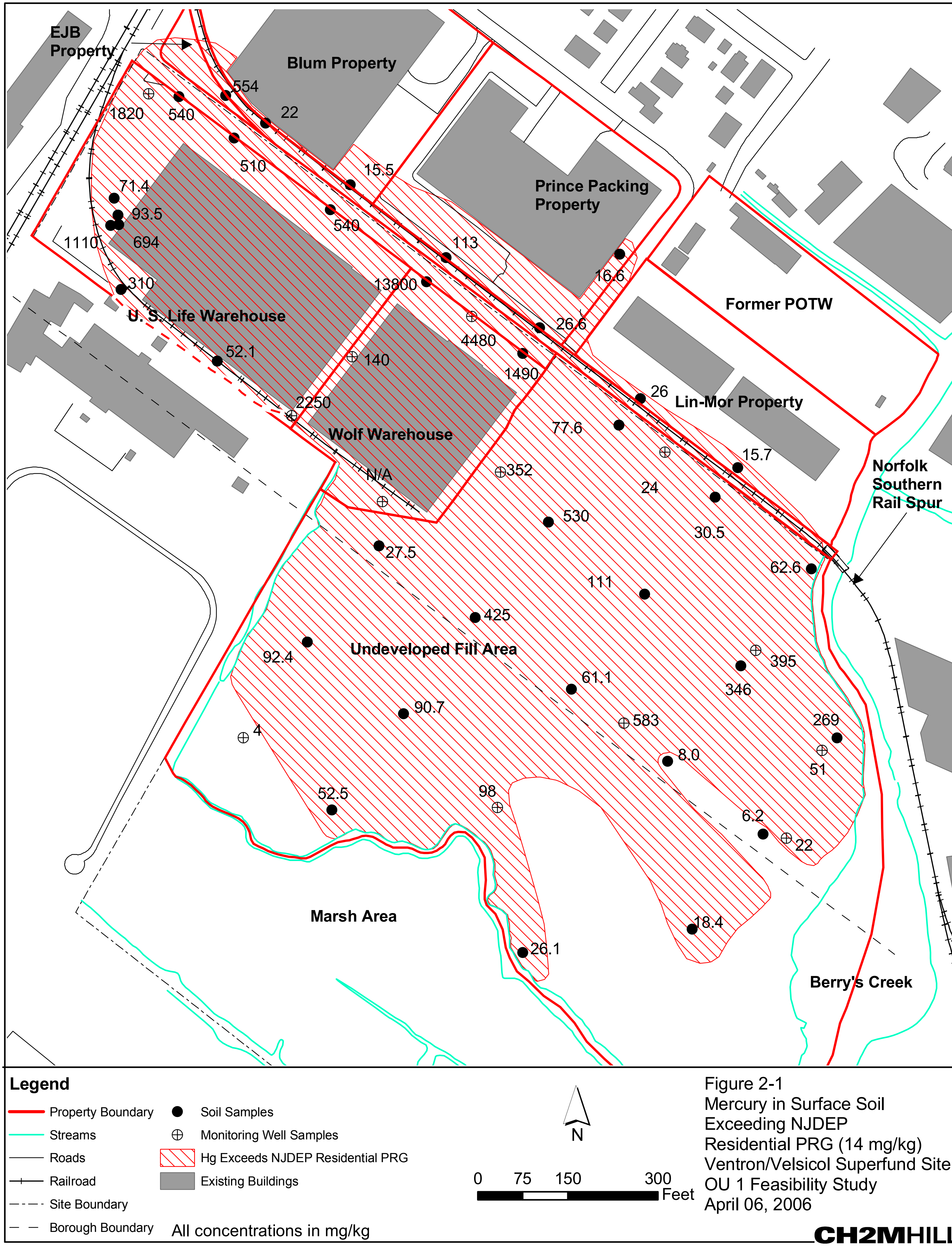
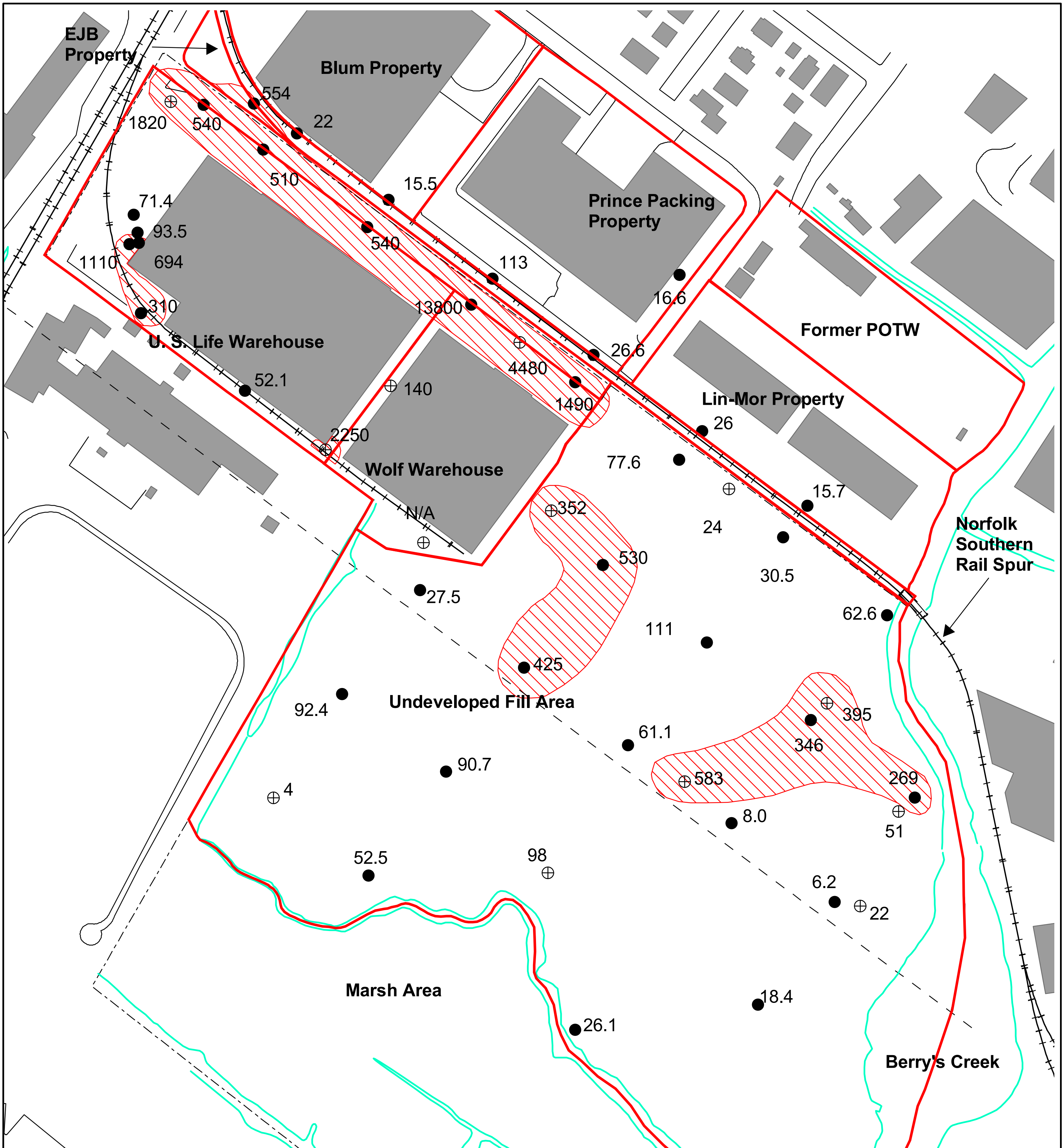


Figure 2-1
Mercury in Surface Soil
Exceeding NJDEP
Residential PRG (14 mg/kg)
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006



Legend

Property Boundary	Monitoring Well Samples
Streams	Soil Samples
Roads	Hg Exceeds NJDEP Non-Residential PRG
Railroad	Existing Buildings
Site Boundary	
Borough Boundary	

All concentrations in mg/kg

N

0 75 150 300 Feet

Figure 2-2
Mercury in Surface Soil
Exceeding NJDEP
Non-Residential PRG (270 mg/kg)
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL

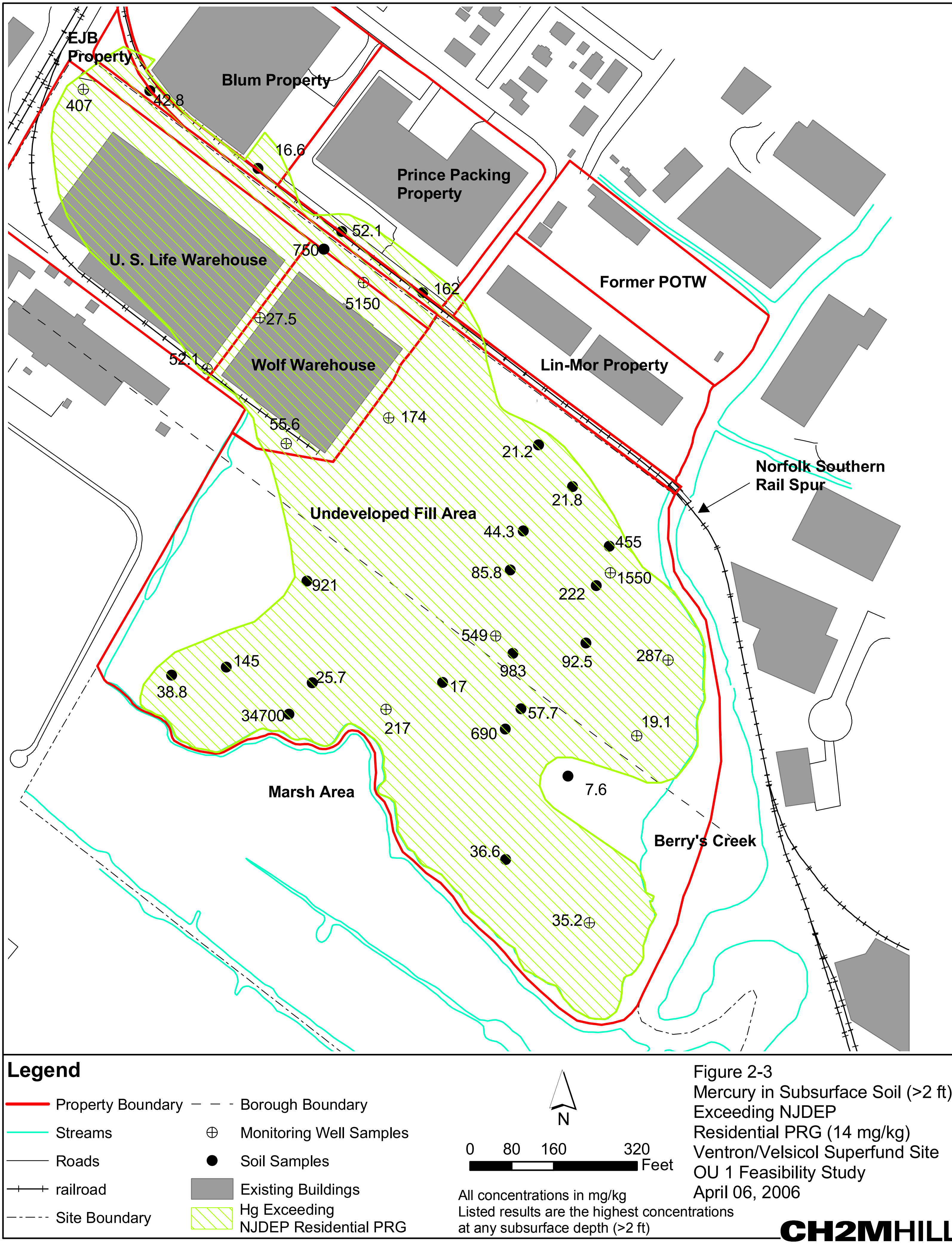
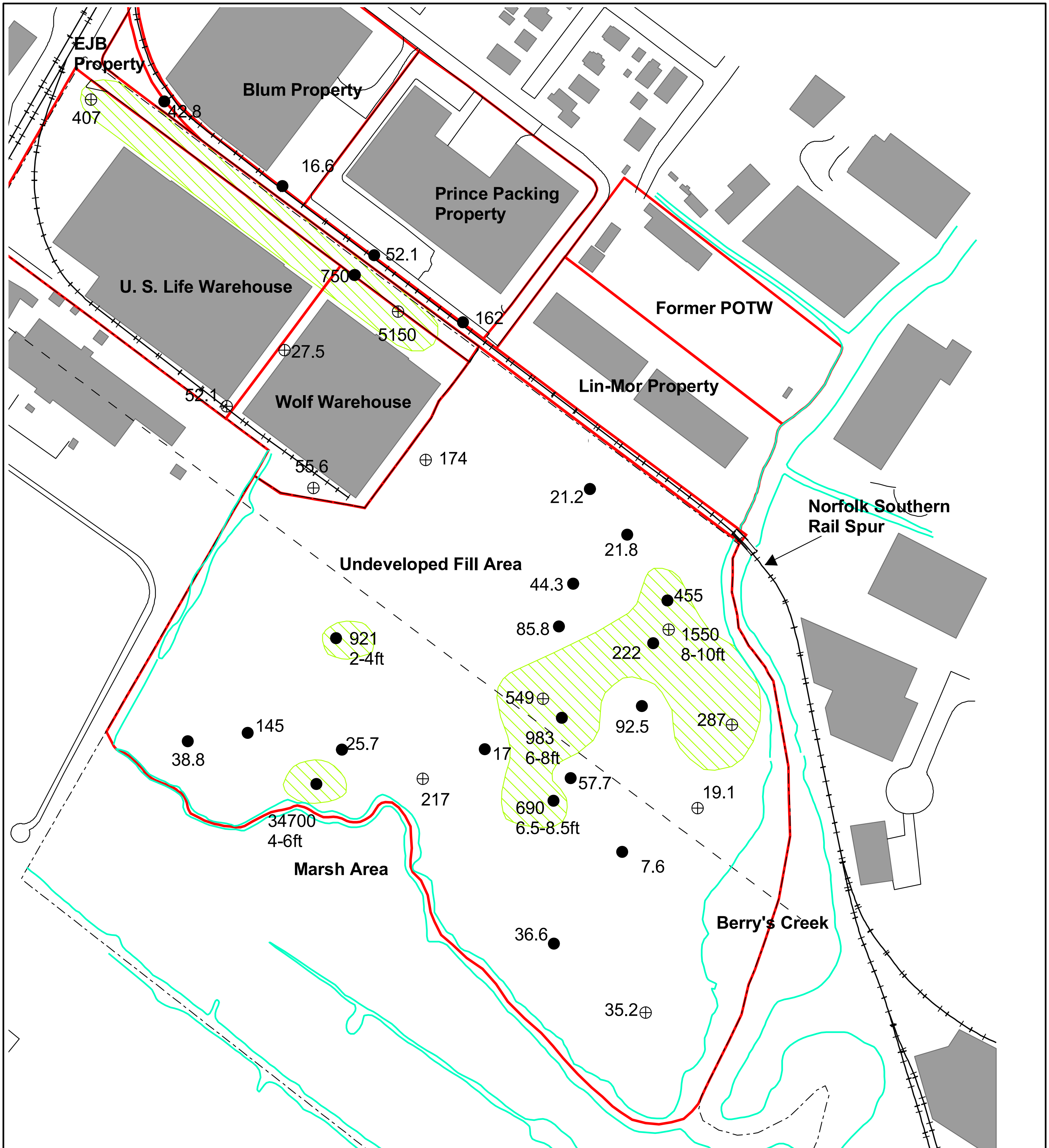


Figure 2-3
Mercury in Subsurface Soil (>2 ft) Exceeding NJDEP Residential PRG (14 mg/kg)
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL



Legend

- Property Boundary
- Streams
- Roads
- Railroad
- Site Boundary
- Borough Boundary
- Monitoring Well Samples
- Soil Samples
- Hg Exceeding NJDEP Non-Residential PRG
- Existing Buildings

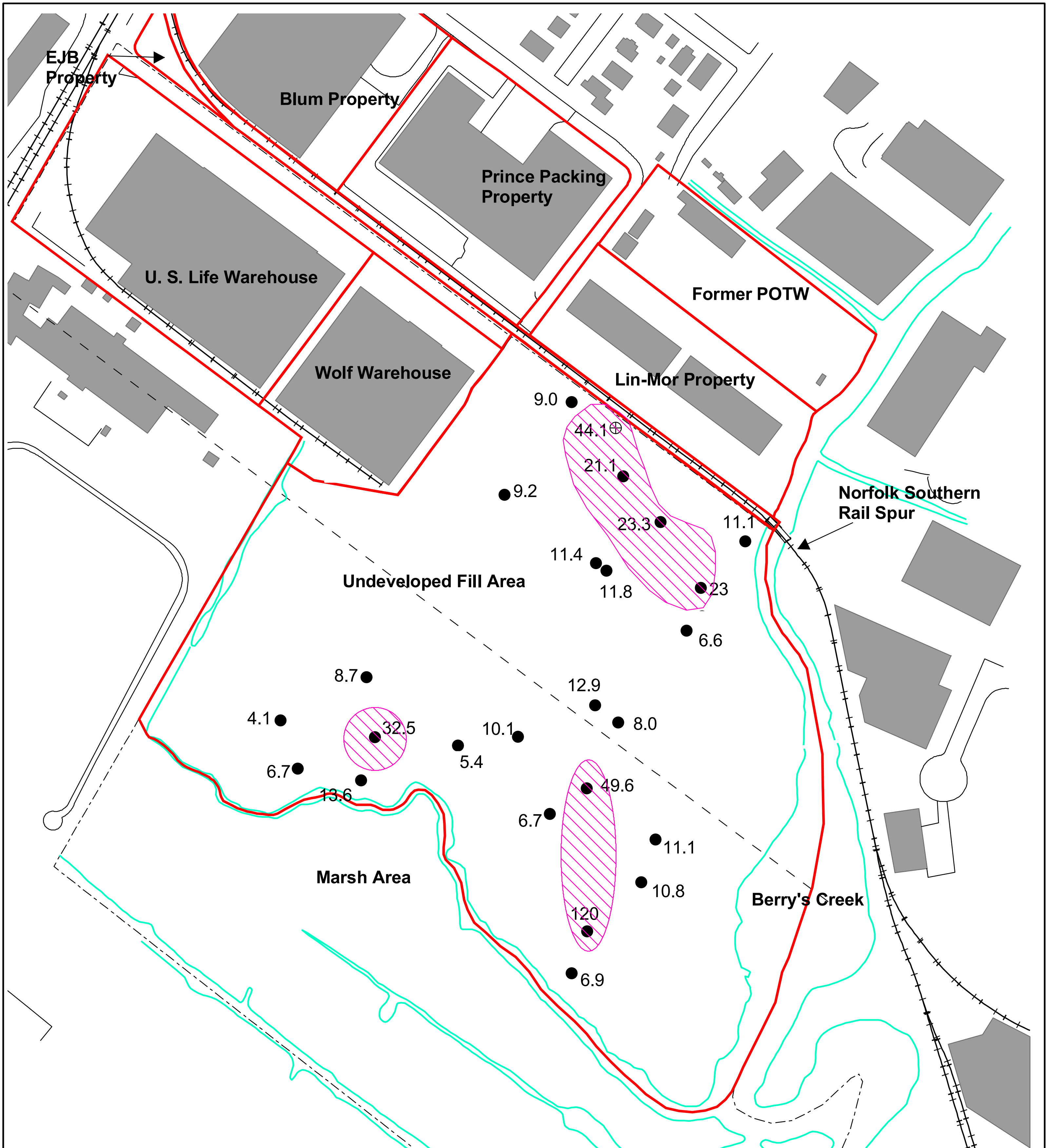
All concentrations in mg/kg
Listed results are the highest concentrations at any subsurface depth (>2 ft)

N

0 80 160 320 Feet

Figure 2-4
Mercury in Subsurface Soil (>2 ft)
Exceeding NJDEP
Non-Residential PRG (270 mg/kg)
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL



Legend

Property Boundary
Streams
Roads
Railroad
Site Boundary
Borough Boundary
Monitoring Well Samples
Soil Samples
Existing Buildings
As Exceeding NJDEP PRG

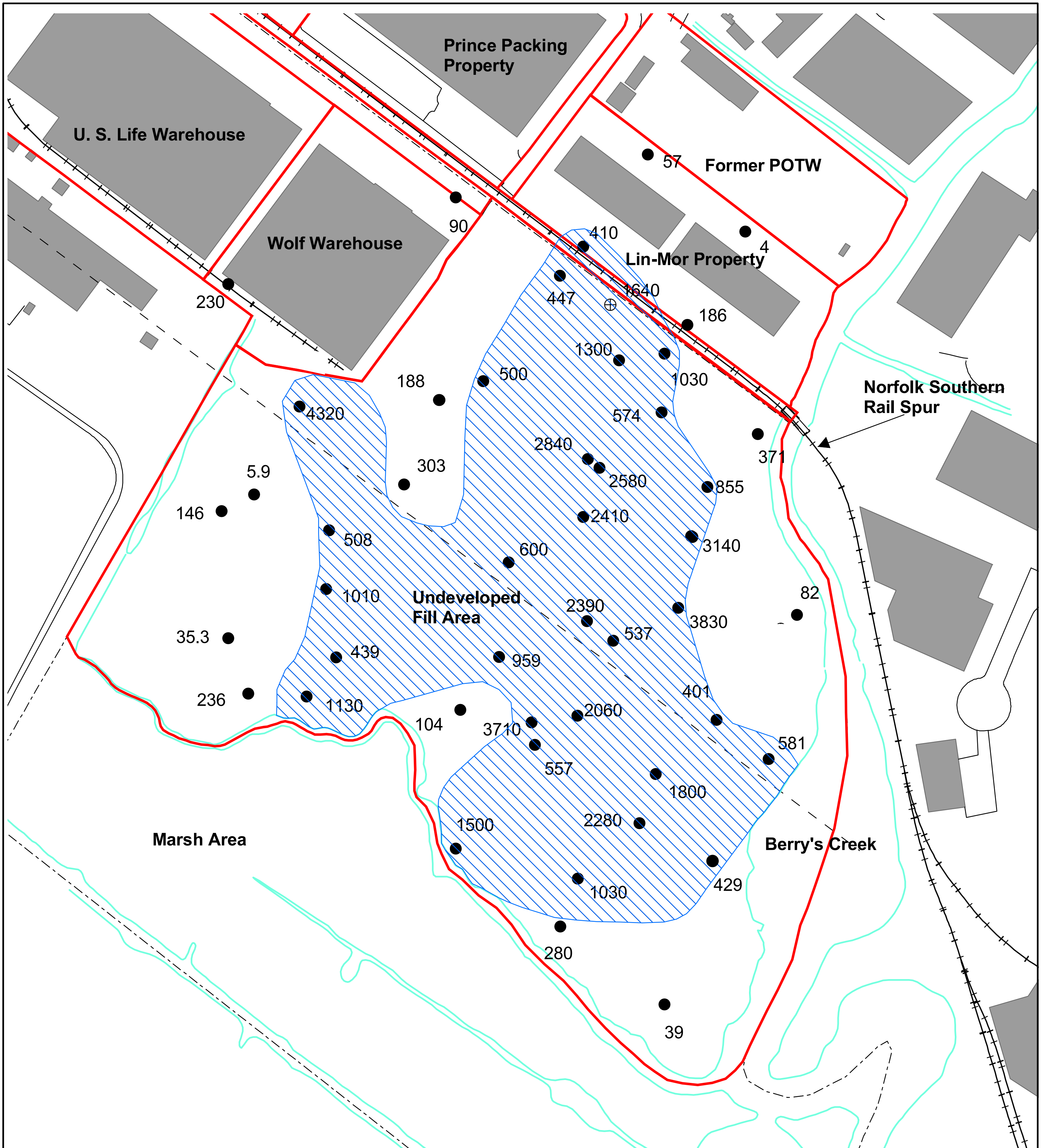
N

0 80 160 320 Feet

All concentrations in mg/kg
Listed results are highest concentrations at any depth

Figure 2-5
Arsenic in Soil, All Depths, Exceeding NJDEP Residential and Non-Residential PRG (20 mg/kg)
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL



Legend

Property Boundary	Borough Boundary		
Streams	Monitoring Well Samples		
Roads	Soil Samples		
Railroad	Pb Exceeding NJDEP Residential PRG		
Site Boundary			

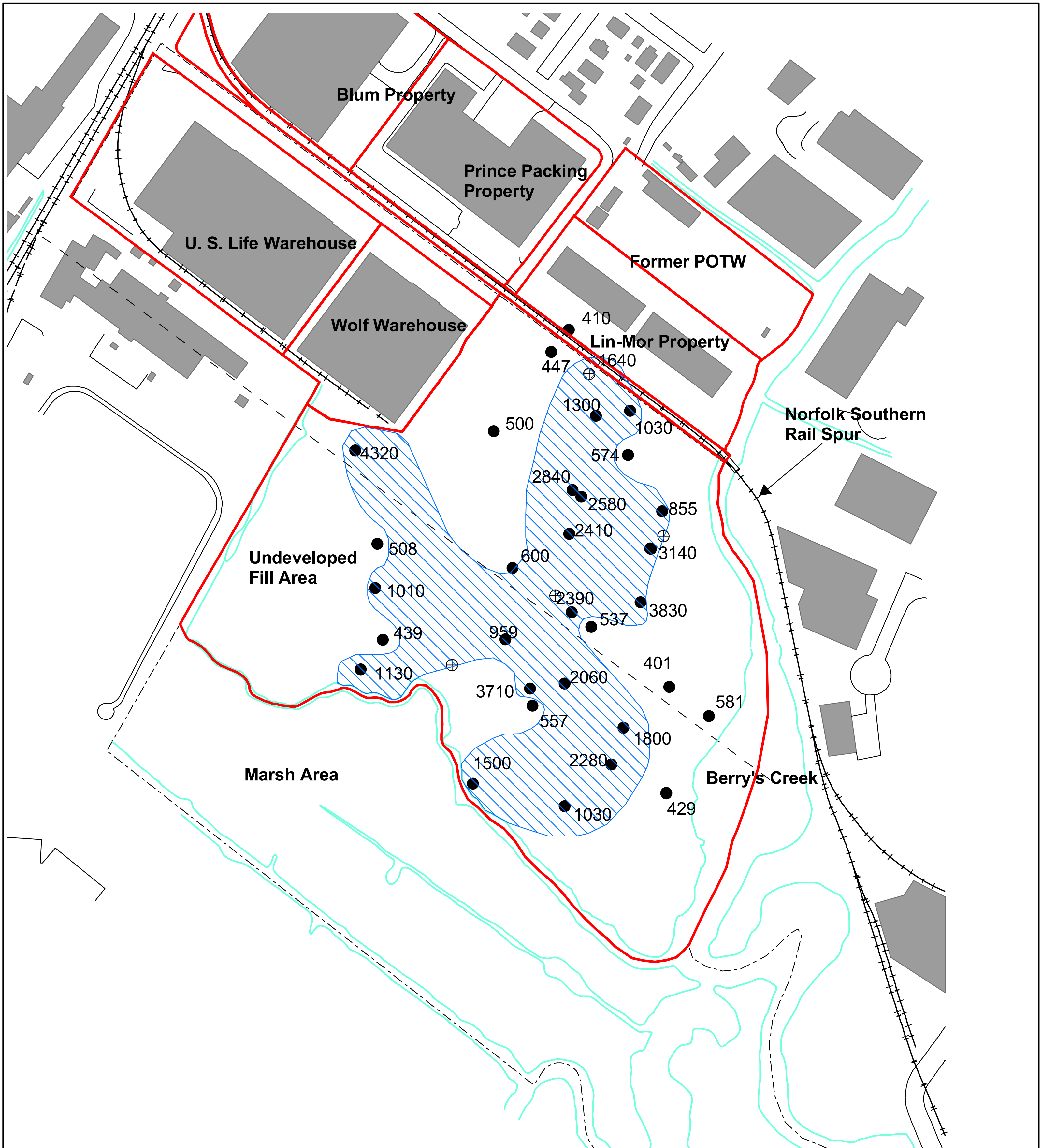
All concentrations in mg/kg
Listed results are highest concentrations at any depth

N

0 75 150 300 Feet

Figure 2-6
Lead in Soil, All Depths, Exceeding NJDEP Residential PRG (400 mg/kg)
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL



Legend

- Property Boundary
- Streams
- Roads
- Railroad
- Site Boundary
- Borough Boundary
- Monitoring Well Samples
- Soil Samples
- Pb Exceeding NJDEP Non-Residential PRG

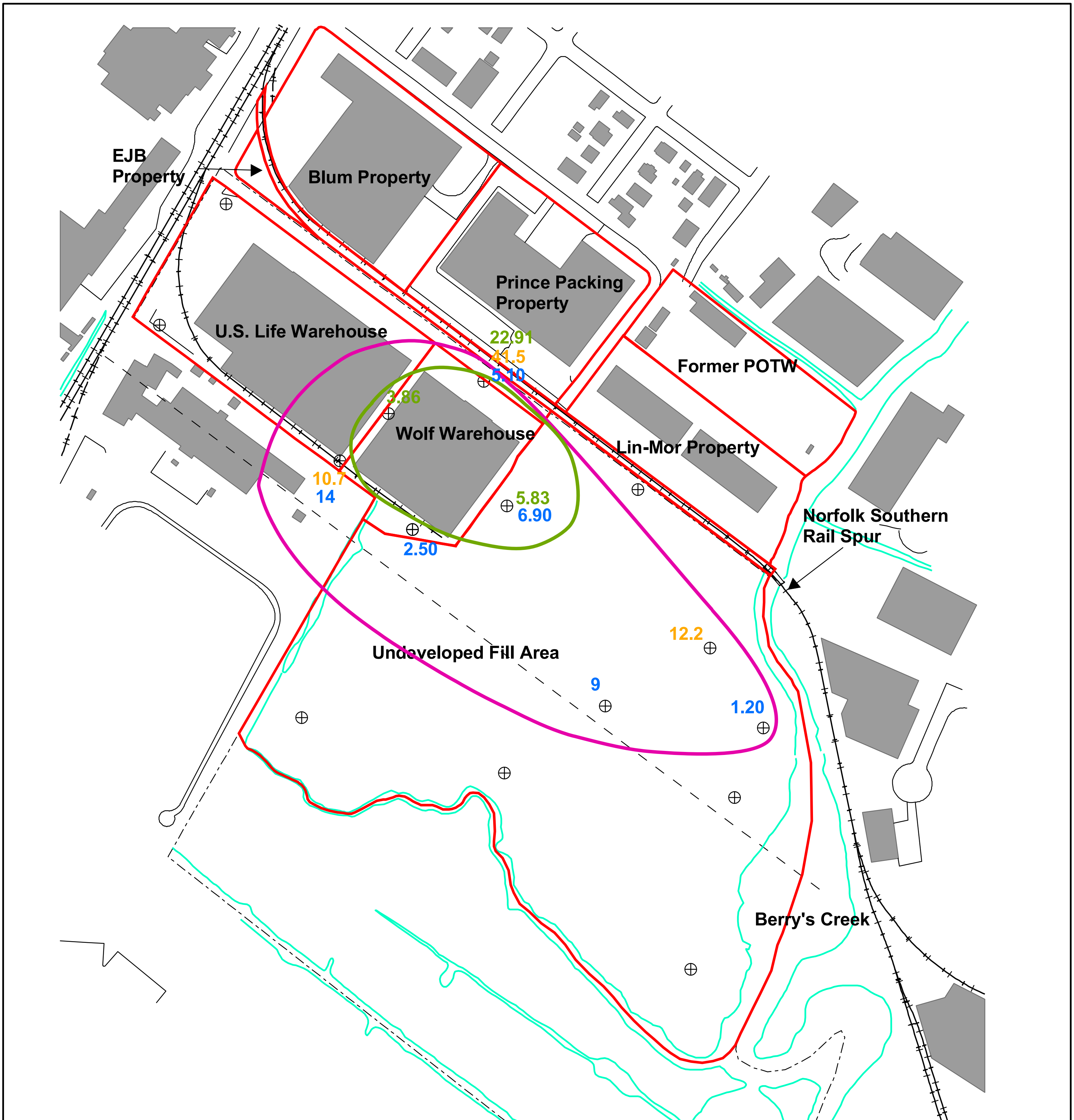
N

0 75 150 300 Feet

All concentrations in mg/kg
Listed results are highest concentrations at any depth

Figure 2-7
Lead in Soil, All Depths,
Exceeding NJDEP
Non-Residential PRG (600 mg/kg)
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL



Legend

- ⊕ Monitoring Well Samples
- Roads
- Streams
- Site Boundary
- Railroad
- Any Compound in Groundwater Exceeding PRGs (As = 8 ug/L, Hg = 2 ug/L, Benzene = 1 ug/L)
- Borough Boundary
- Existing Buildings
- Property Boundary
- 5.83 - Measured Mercury Concentrations (ug/L)
- 12.2 - Measured Arsenic Concentrations (ug/L)
- 9 - Measured Benzene Concentrations (ug/L)
- Mercury in Groundwater Exceeding PRGs

N

0 75 150 300 Feet

Figure 2-8
Groundwater Contaminants Exceeding PRGs
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL

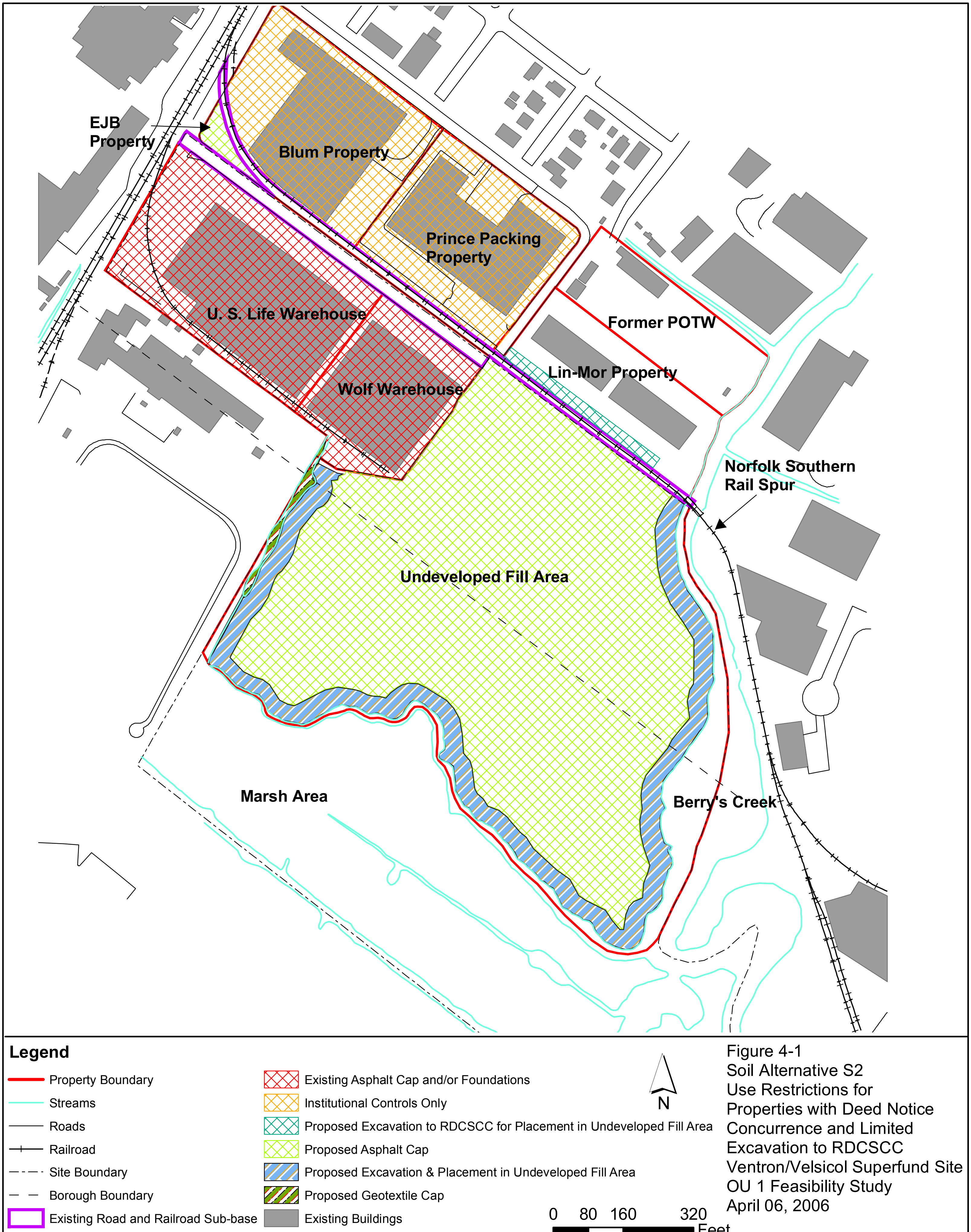


Figure 4-1
Soil Alternative S2
Use Restrictions for
Properties with Deed Notice
Concurrence and Limited
Excavation to RDCSCC
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL

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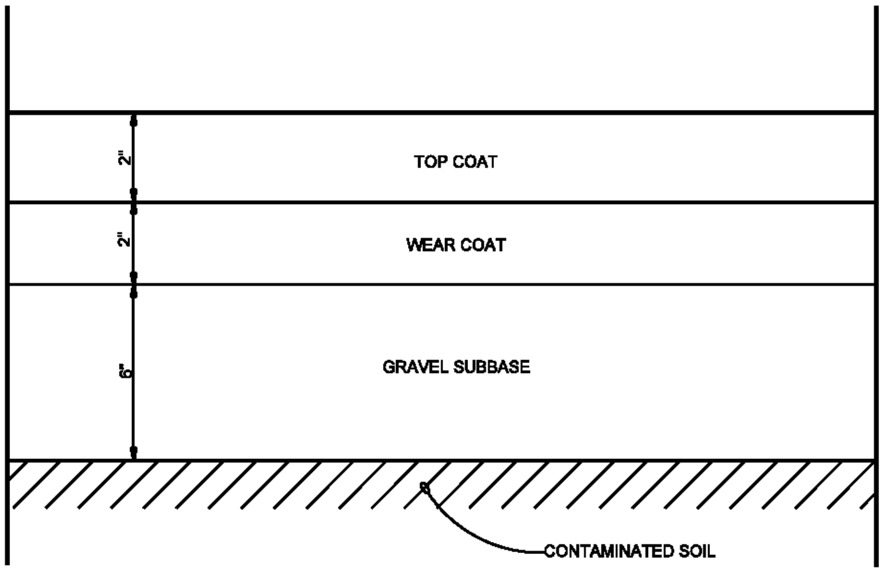

ASPHALT COVER
NTS

Figure 4-2
GENERAL CAP CROSS-SECTION
VENTRON/VELSICOL SUPERFUND SITE
OU 1 FEASIBILITY STUDY
APRIL 6, 2006

CH2MHILL

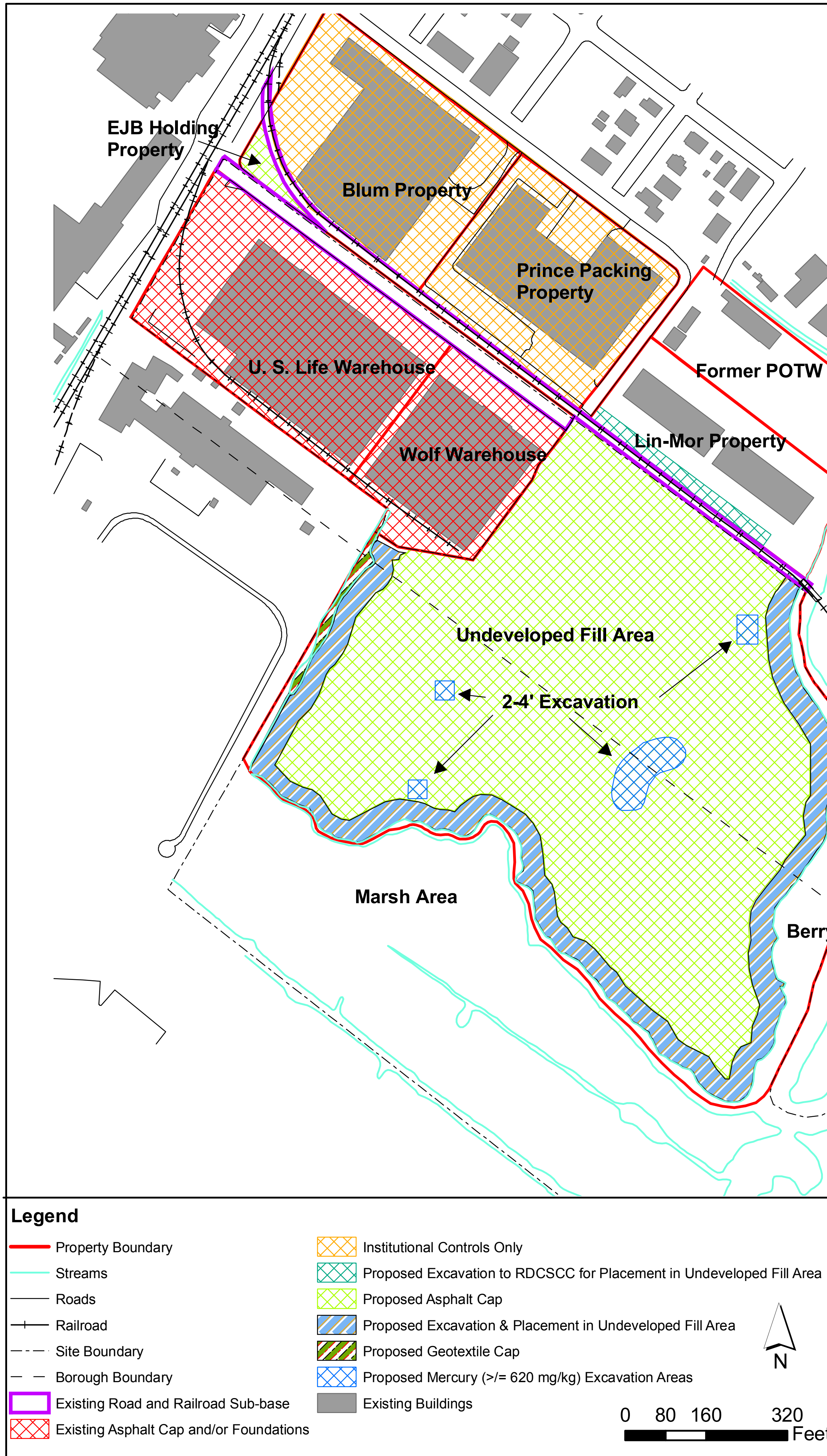

Figure 4-3
Soil Alternative S3
Excavation of Undeveloped Area with >/= 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL

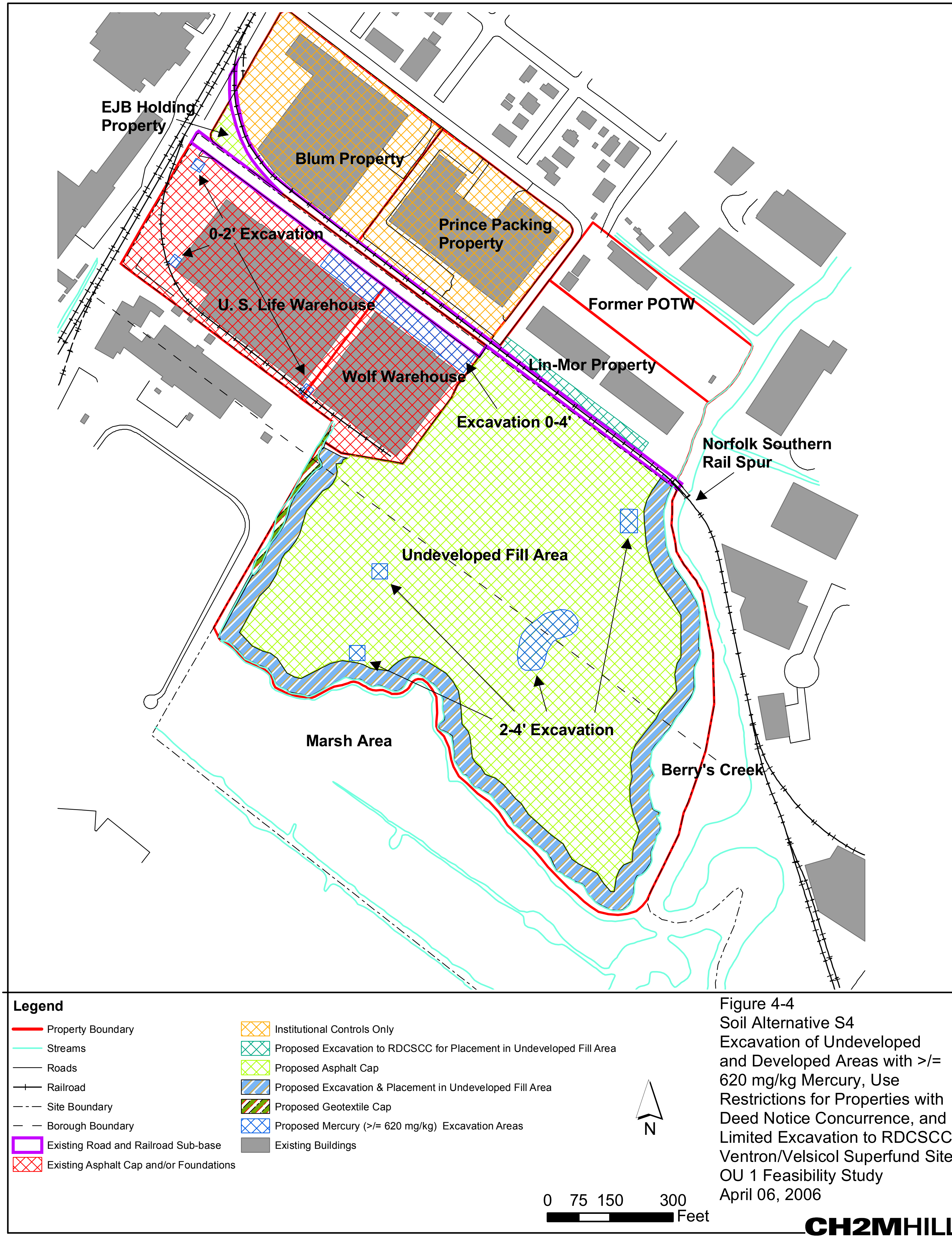

Figure 4-4
Soil Alternative S4
Excavation of Undeveloped and Developed Areas with >/= 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL

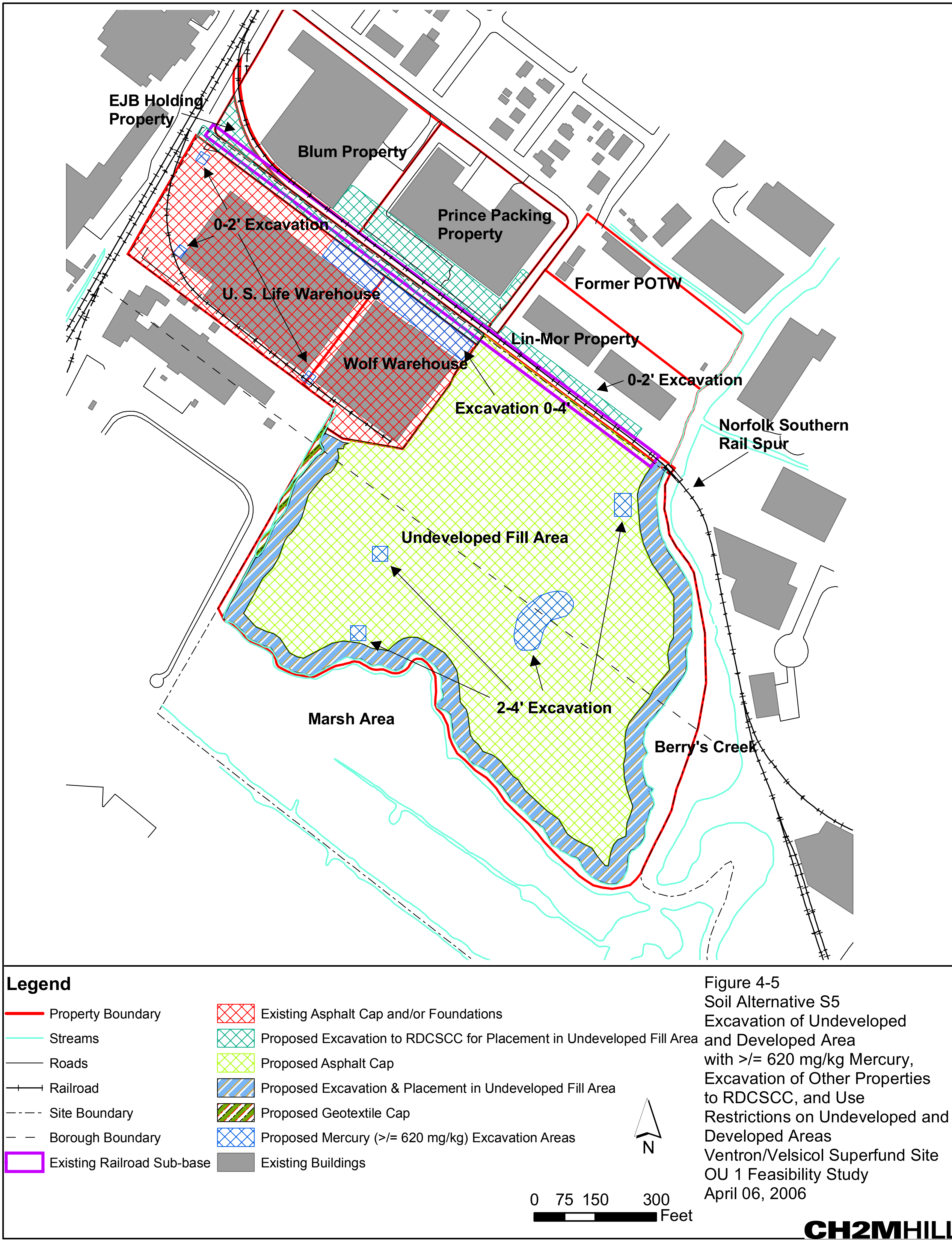

Figure 4-5
Soil Alternative S5
Excavation of Undeveloped and Developed Area with >/= 620 mg/kg Mercury, Excavation of Other Properties to RDCSCC, and Use Restrictions on Undeveloped and Developed Areas
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL

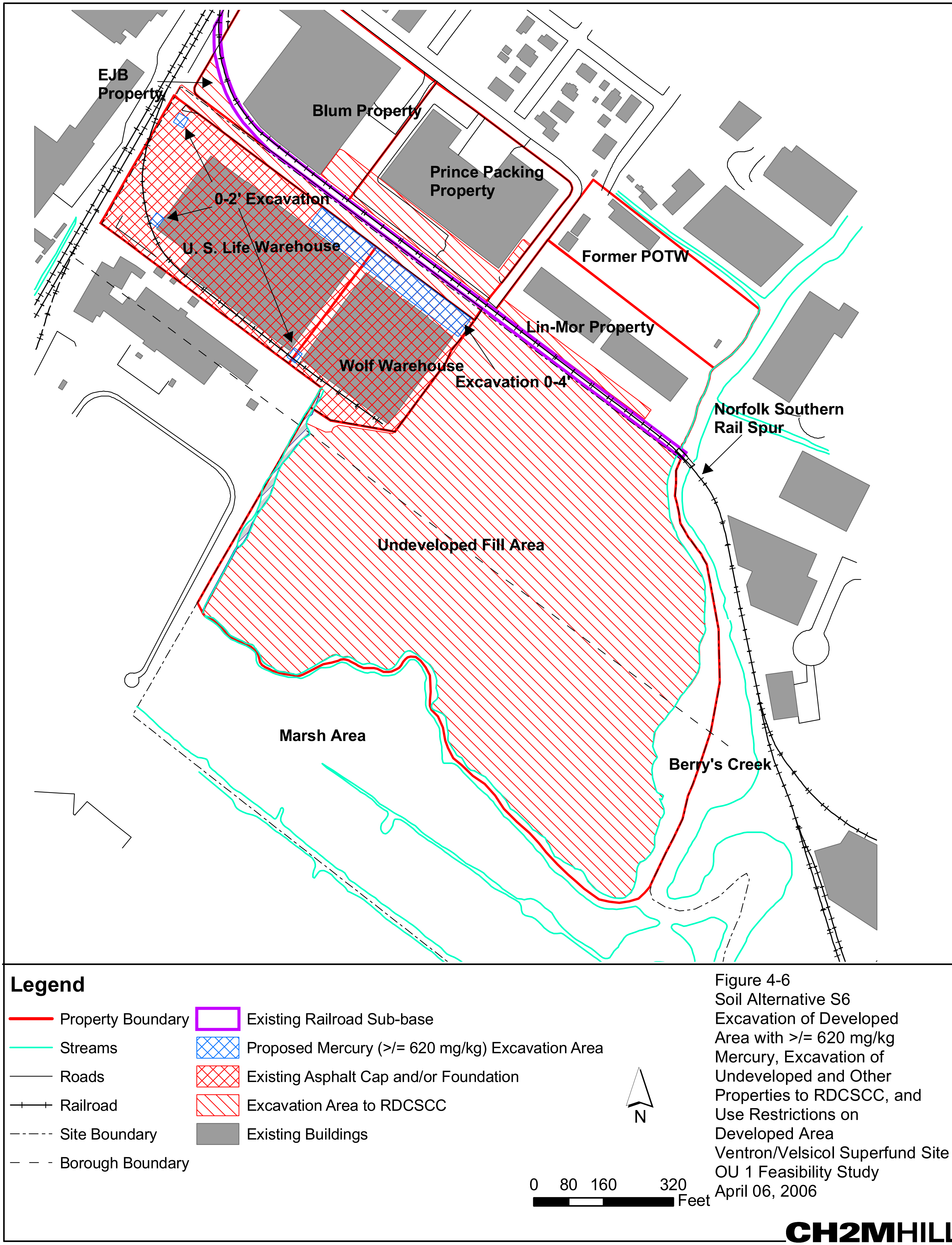

Figure 4-6
Soil Alternative S6
Excavation of Developed Area with >/= 620 mg/kg Mercury, Excavation of Undeveloped and Other Properties to RDCSCC, and Use Restrictions on Developed Area
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL

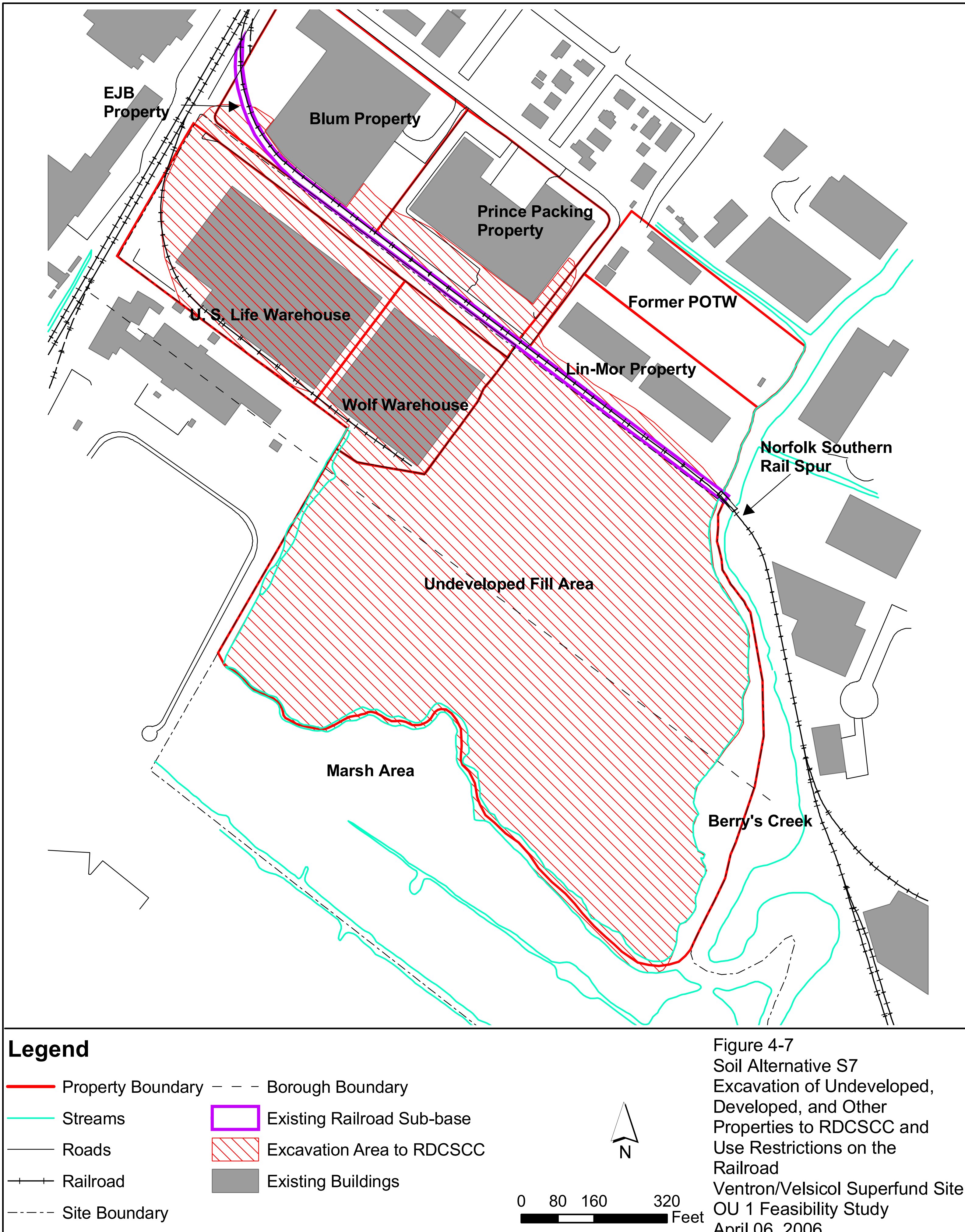

Figure 4-7
Soil Alternative S7
Excavation of Undeveloped, Developed, and Other Properties to RDCSCC and Use Restrictions on the Railroad
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL

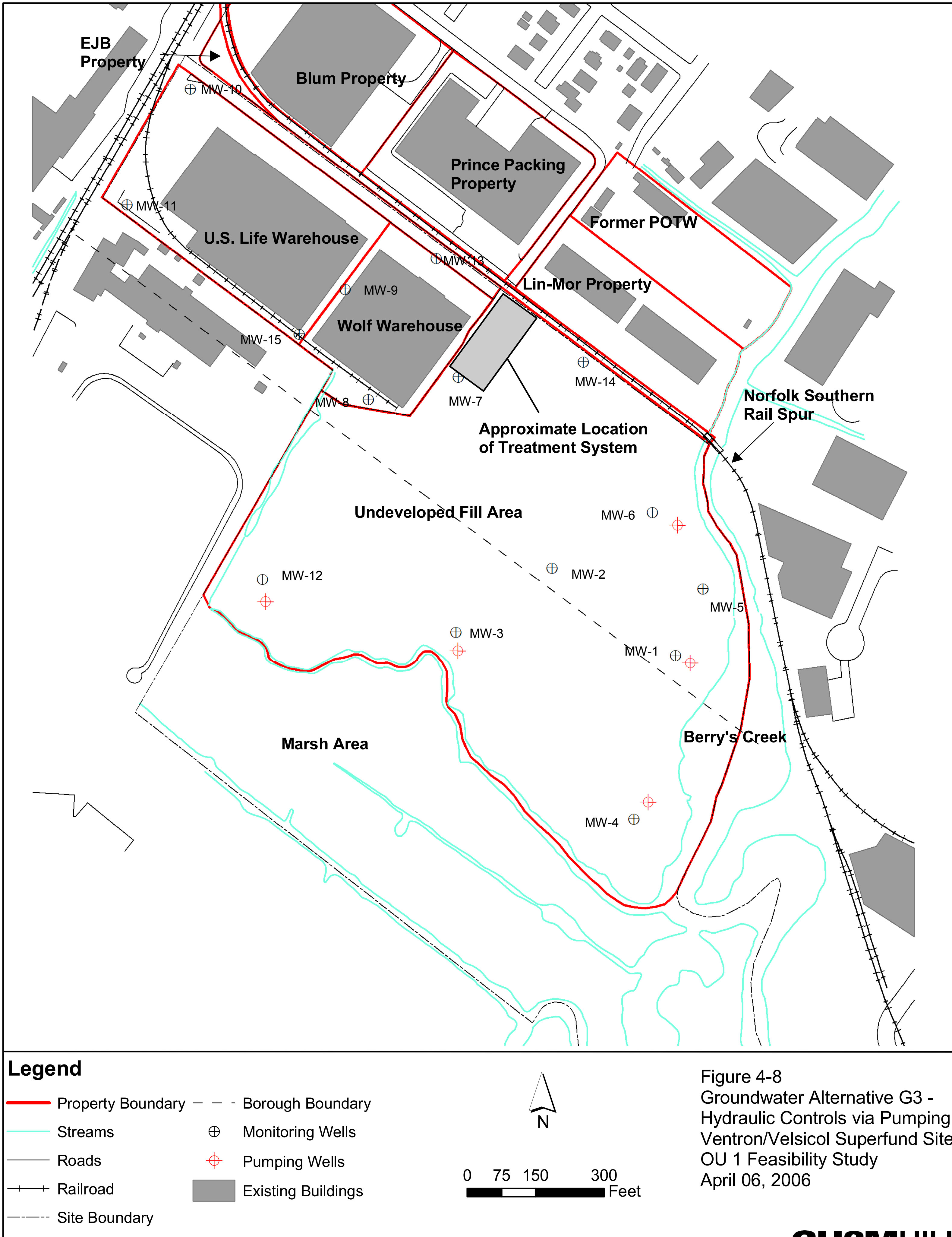

Figure 4-8
Groundwater Alternative G3 -
Hydraulic Controls via Pumping
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

CH2MHILL

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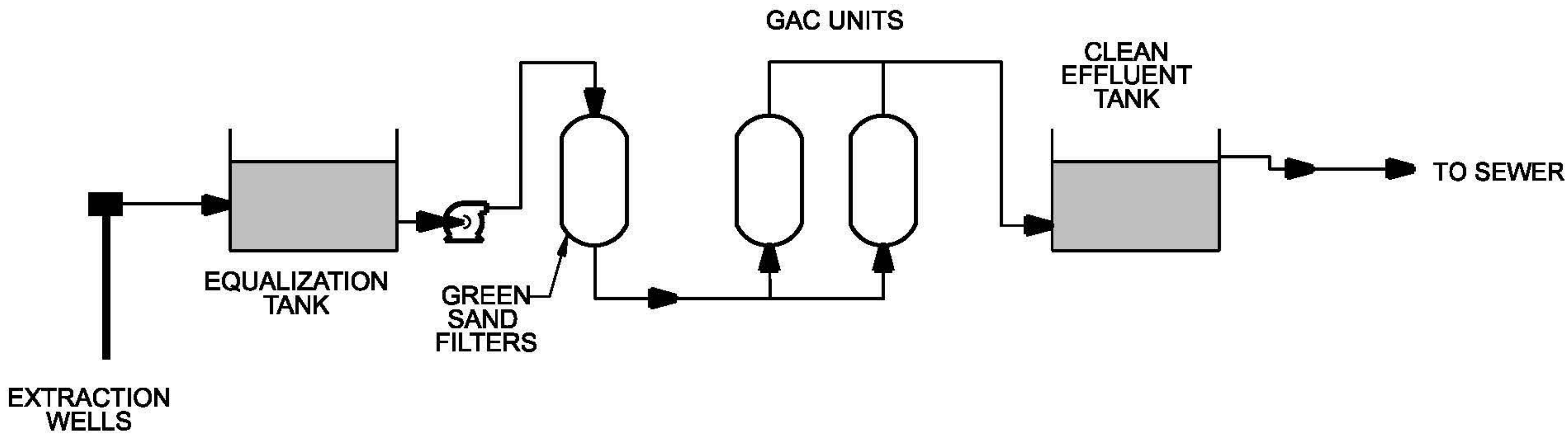

Figure 4-9
GROUNDWATER ALTERNATIVE G3
CONCEPTUAL GAC SYSTEM PROCESS
VENTRON/VELSICOL SUPERFUND SITE
OU 1 FEASIBILITY STUDY
APRIL 6, 2006

CH2MHILL

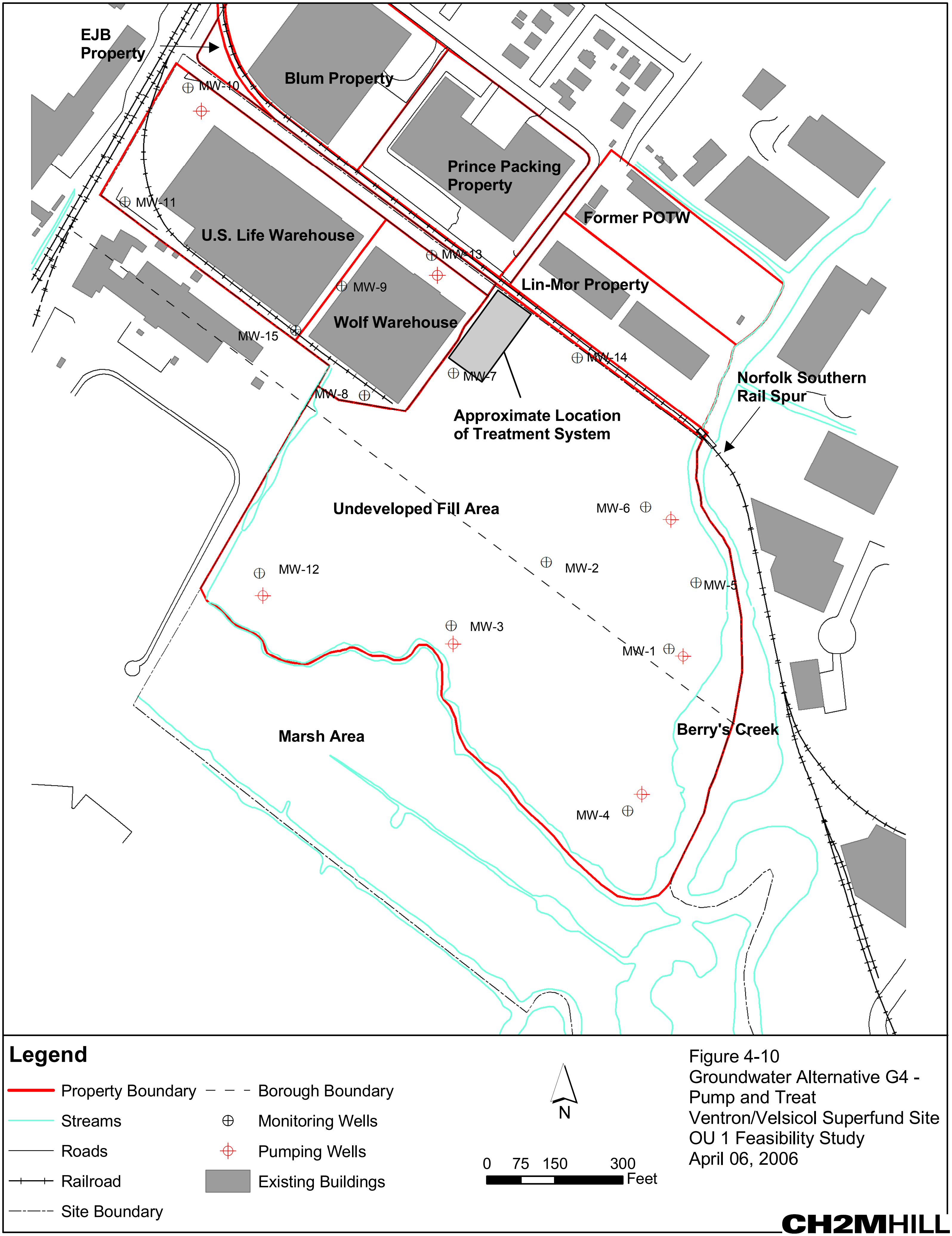

Figure 4-10
Groundwater Alternative G4 - Pump and Treat
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

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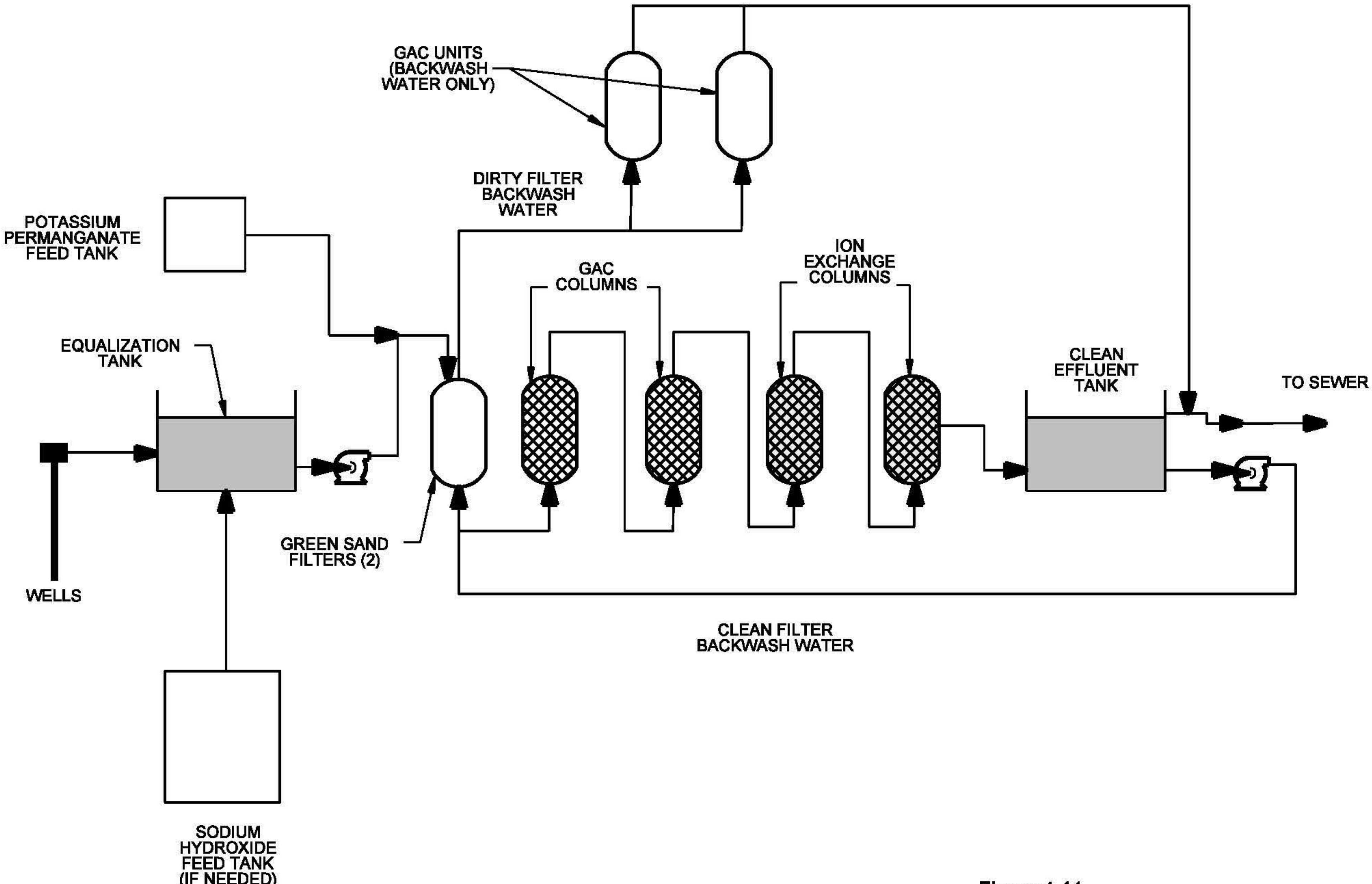

Figure 4-11
GROUNDWATER ALTERNATIVE G4 CONCEPTUAL ION EXCHANGE SYSTEM PROCESS
VENTRON/VELSICOL SUPERFUND SITE
OU 1 FEASIBILITY STUDY
APRIL 6, 2006

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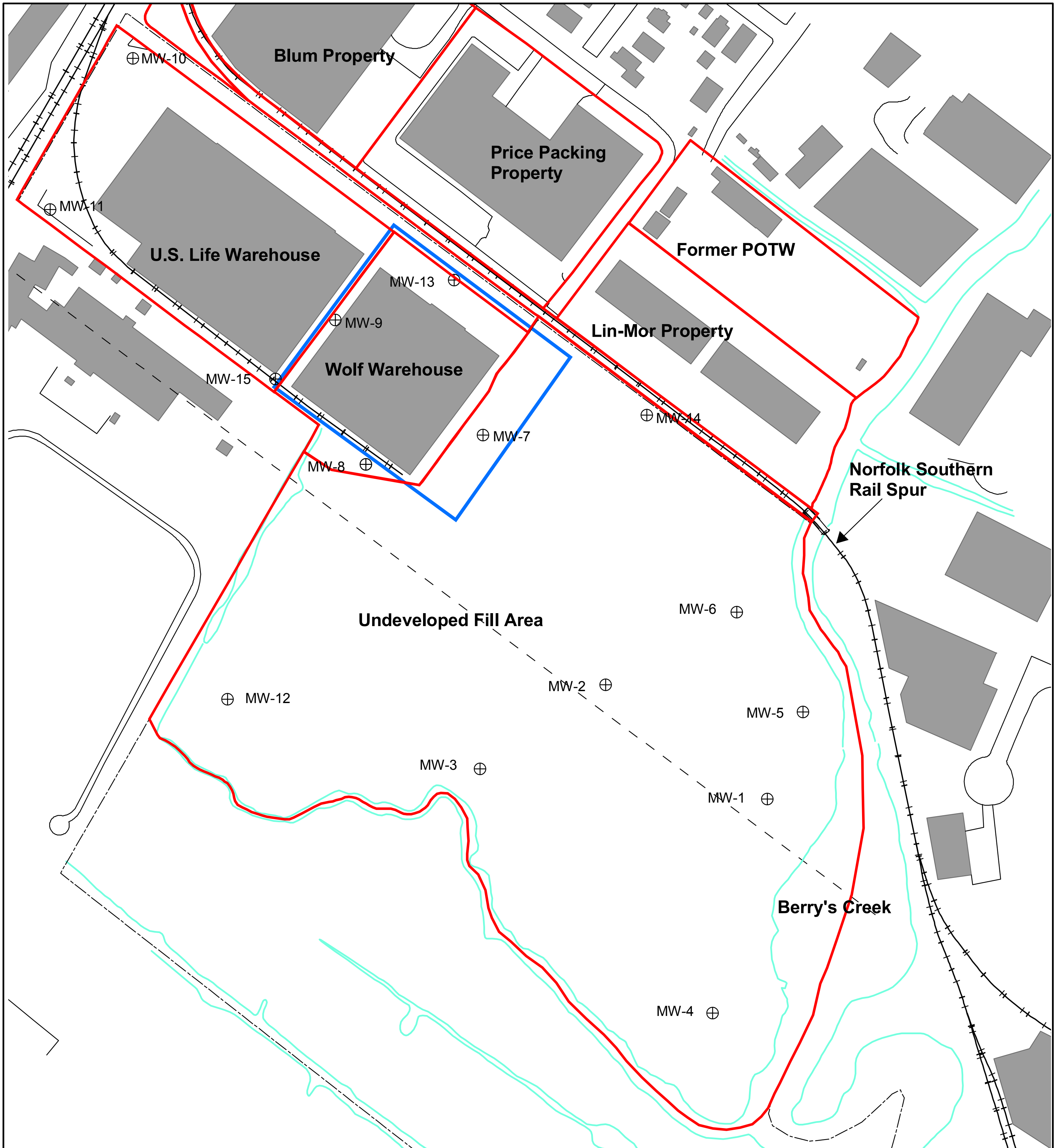

Legend

- Property Boundary
- Streams
- Roads
- Railroad
- Site Boundary
- Borough Boundary
- Monitoring Wells
- Vertical Hydraulic Barrier Alignment
- Existing Buildings

Figure 4-12
Groundwater Alternative G5 -
Vertical Hydraulic Barrier
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

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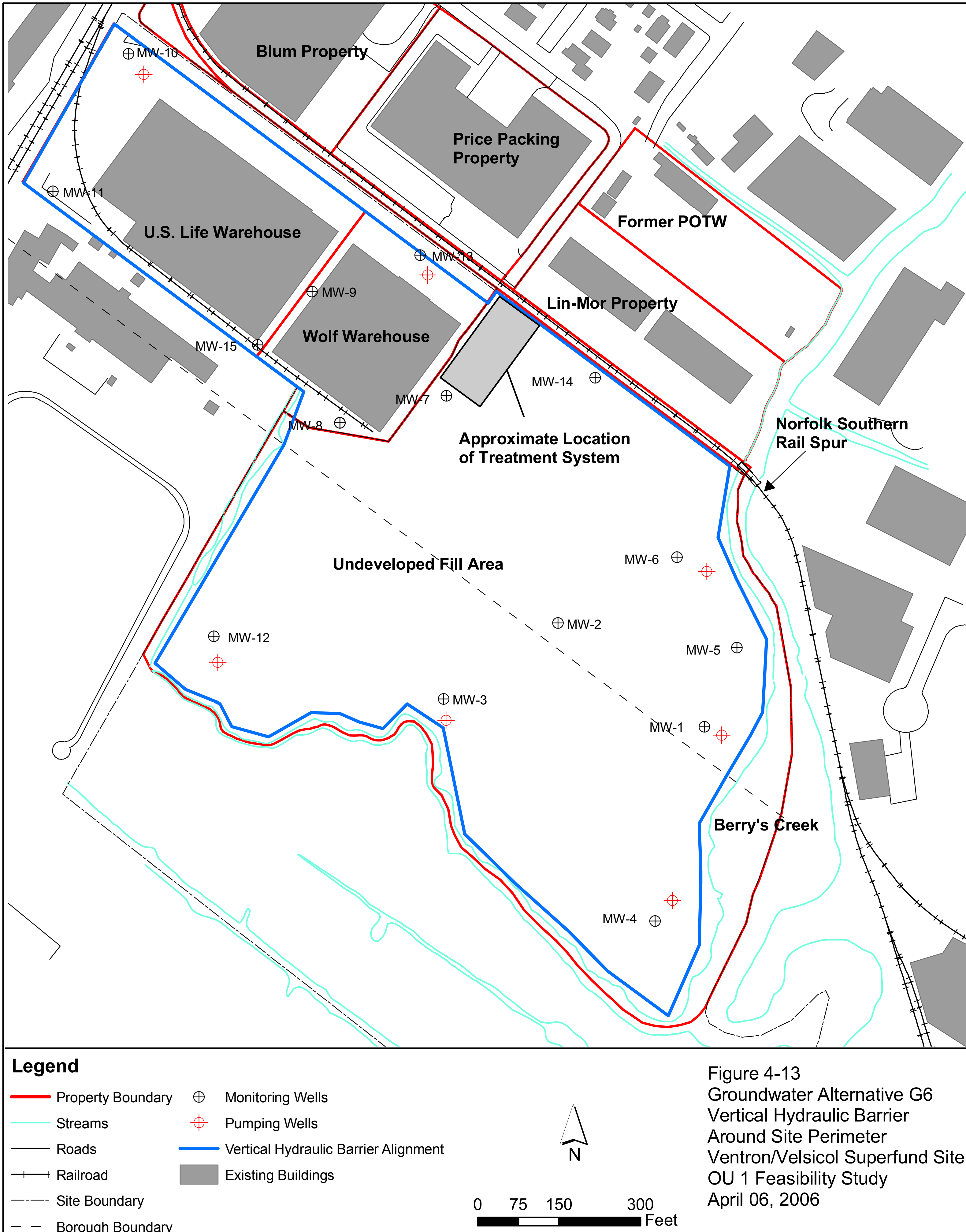

Figure 4-13
Groundwater Alternative G6
Vertical Hydraulic Barrier
Around Site Perimeter
Ventron/Velsicol Superfund Site
OU 1 Feasibility Study
April 06, 2006

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Feasibility Study Report
Operable Unit 1
Ventron/Velsicol Superfund Site
Wood-Ridge/Carlstadt, New Jersey

Prepared for

Morton International, Inc.
Chicago, Illinois

April 06, 2006

CH2MHILL

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Contents

Appendixes

Tables

Figures

Abbreviations and Acronyms

ARAR	applicable or relevant and appropriate requirement
BCUA	Bergen County Utilities Authority
Berk	F.W. Berk and Company
BITM	Background Investigation Technical Memorandum
bgs	below ground surface
BOD	biochemical oxygen demand
CEA	Classification Exception Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Act Information Systems
COC	contaminant of concern
COD	chemical oxygen demand
COPC	Contaminant of potential concern
Custodial Trust	Custodial Trust Agreement dated August 19, 2002
ELCR	excessive lifetime cancer risk
ERA	ecological risk assessment
FS	feasibility study
GAC	granular activated carbon
gpd	gallons per day
gpm	gallons per minute
GWQC	Groundwater Quality Criteria
HI	hazard index
HHRA	human health risk assessment
IPP	Industrial Pretreatment Program
IGWSCC	Impact to Groundwater Soil Cleanup Criteria
LDR	land disposal restriction
LEL	lower explosive limit
LTTD	low temperature thermal desorption
MCL	maximum contaminant limit
MG	million gallons
mg/kg	milligram per kilogram
mg/L	milligram per liter
Morton	Morton International, Inc.
MOU	memorandum of understanding
msl	mean sea level
NEPA	National Environmental Policy Act

NCP	National Contingency Plan
N.J.A.C.	*New Jersey Administrative Code*
NJDEP	New Jersey Department of Environmental Protection
NJPDES	New Jersey Pollutant Discharge Elimination System
NPL	National Priorities List
NRDCSCC	Non-residential Direct Contact Soil Cleanup Criteria
NWI	NWI Land Management, Inc.
O&M	operations and maintenance
OU1	Operable Unit 1
OU2	Operable Unit 2
PAH	polycyclic aromatic hydrocarbon
POTW	publicly owned treatment works
PRG	preliminary remediation goal
RAO	remedial action objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RDCSCC	Residential Direct Contact Soil Cleanup Criteria
Resolution	Resolution of the Berry's Creek/Wood-Ridge Site Action Committee
RI	remedial investigation
ROD	record of decision
SDWA	Safe Drinking Water Act
Stipulation	Stipulation and Supplementary Order Approving Cooperative Agreement for Remedial Investigation and Feasibility Study and Amending Procedural Order Involving Remedy
TBC	to be considered
TCLP	toxicity characteristic leaching procedure
Thiokol	Thiokol Corporation
TMV	toxicity, mobility, or volume
μg/kg	microgram per kilogram
μg/L	microgram per liter
USEPA	U.S. Environmental Protection Agency
UTS	Universal Treatment Standard
Velsicol	Velsicol Chemical Corporation
Ventron	Ventron Corporation
VOC	volatile organic compound
Wolf	Robert and Rita Wolf
WRCC	Wood-Ridge Chemical Company

1 Introduction

1.1 Purpose and Organization of Report

This Operable Unit 1 (OU1) Feasibility Study (FS) was prepared on behalf of Morton International, Inc. (Morton) and presents the results of the alternatives evaluation for the Remedial Investigation/Feasibility Study (RI/FS) process for the Ventron/Velsicol site (site), located in Wood-Ridge and Carlstadt, New Jersey. The site is designated as a National Priorities List (NPL) site identified by the U.S. Environmental Protection Agency (USEPA) number NJD980529879, and bearing Comprehensive Environmental Response, Compensation, and Liability Act Information Systems (CERCLIS) ID number 02C7.

The RI/FS is required by the Resolution of the Berry's Creek/Wood-Ridge Site Action Committee (Resolution) with the New Jersey Department of Environmental Protection (NJDEP), executed on August 15, 1996. The Resolution is an amendment to the October 26, 1984, Stipulation and Supplementary Order Approving Cooperative Agreement for Remedial Investigation and Feasibility Study and Amending Procedural Order Involving Remedy (Stipulation). The Stipulation covers the approximately 38-acre Ventron/Velsicol site and the areas of Berry's Creek potentially affected by industrial activity at the site.

This FS covers the OU1 area, which generally consists of two main areas, designated as the developed area (approximately 16 acres currently being used for warehousing) and the undeveloped fill area (approximately 19 acres that was historically filled). Areas to the north-northeast of the developed area are also included within the OU1 FS boundary. More details of the FS target areas are included in Section 1.2 of this FS.

In November 2003, a technical memorandum titled Draft Technical Memorandum for Screening of Remedial Technologies and Development of Alternatives (Tech Memo) (Exponent, 2003) was submitted to NJDEP/USEPA outlining proposed remedial technologies and alternatives for OU1. The November 2003 submission and comments to that submittal from NJDEP/USEPA (a letter dated April 23, 2004) were used to develop the *Agency Review Draft FS*, which was submitted to NJDEP/USEPA on January 14, 2005. Responses to the comments generated by the Agency Reviews of the Draft FS (dated April 1, 2005, December 7, 2005, and March 10, 2006) have been incorporated into this FS. The outcome of subsequent discussions with NJDEP and USEPA throughout the preparation of this report has also been used in the preparation of this FS.

NJDEP and USEPA, along with input from the public, will use this information to develop a Record of Decision (ROD), outlining the remedial actions in accordance with the National Contingency Plan (NCP). The criteria for remedy selections under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) require that Superfund remedial actions satisfy the following requirements:

- Protect human health and the environment
- Comply with applicable or relevant and appropriate requirements (ARARs) of federal and state environmental laws within a reasonable time frame
- Be cost effective
- Use permanent solutions and alternative treatment technologies to the maximum extent practicable
- Satisfy the preference for treatment that reduces contaminant toxicity, mobility, or volume (TMV)

As described in the *Remedial Investigation/Feasibility Study Guidance Document* (USEPA, 1988b) and in the *National Oil and Hazardous Substances Contingency Plan* (USEPA 1990), the FS consists of three phases: the development of remedial alternatives, the screening of alternatives, and the detailed analysis of selected alternatives. The following steps were used in developing the remedial alternatives for the site:

- Identification of contaminants of concern (COCs) for the FS
- Identification of ARARs
- Development of remedial action objectives (RAOs)
- Definition of remedial action goals, including:
  - Developing quantitative preliminary remediation goals (PRGs) using chemical-specific ARARs
  - Identifying areas of contamination exceeding PRGs
- Development of general response actions
- Identification and screening of applicable technologies (including innovative technologies)
- Identification and evaluation of technology process options
- Assembly of remaining process options into remedial alternatives
- Evaluation of the remedial alternatives in accordance with the NCP

This report consists of six sections. Section 1 includes the introduction and summarizes OU1 background information, such as the site physical description, site geology and hydrogeology, nature and extent of contamination, COCs used to develop the FS, and a summary of current status of the human health and ecological risk assessments. The development of the ARARs, RAOs, and PRGs for the soil and groundwater target areas that are intended to provide adequate protection of human health and the environment are discussed in Section 2. Section 3 presents the development of general response actions that address remedial action goals and introduces the remedial technologies that were screened to reduce the number of technologies considered in the detailed alternatives. Section 4 assembles the remaining technologies into soil and groundwater remedial action alternatives that achieve some or all of the remedial action goals, and provides a range of levels of remediation and a corresponding range of costs. A detailed analysis of these soil and groundwater alternatives is presented in Section 5. Section 6 includes references used during the preparation of this FS.

1.2 Site Description

The site is located in Bergen County, New Jersey, within the boroughs of Wood-Ridge and Carlstadt. It is an irregularly-shaped, approximately 38-acre area within an industrialized area of northeastern New Jersey. Approximately 16 of the 38 acres are within the Borough of Wood-Ridge, and the remaining 22 acres are within the Borough of Carlstadt. The entire site is generally within the Hackensack Meadowlands area, and the portion of the site in Carlstadt is within the jurisdiction of the New Jersey Meadowlands Commission. The topography across most of the site is generally flat, ranging in elevation from 0 to 12.6 feet above mean sea level (msl). Land use in the immediate vicinity of the site is primarily commercial/industrial. At present, the site is zoned for light industrial use. The New Jersey Meadowlands Commission governs zoning for the portion of the site within the Borough of Carlstadt, while the Borough of Wood-Ridge maintains its own jurisdiction over zoning. Teterboro Airport is located approximately 0.6 mile to the north, State Highway 17 is approximately 500 feet to the west, and the Meadowlands Sports complex is approximately 1 mile to the south. The closest residential area is approximately 750 feet to the north-northeast. Figure 1-1 shows the site location. Currently, the northern portion of the site (generally designated as the developed area) is used for active industrial operations. The southern portion of the site (designated as the undeveloped fill area) is a vegetated area that is not used.

In accordance with direction from NJDEP in an April 1, 1999, letter, the site has been divided into two operable units. OU1 generally consists of the uplands area (soil and groundwater), while Operable Unit 2 (OU2) consists of the adjacent marsh areas and water bodies. In previous documents, OU1 has been generally subdivided into a developed area and an undeveloped fill area, based on the current use. This nomenclature has been retained for this FS. In addition, properties to the north, designated as offsite properties in the RI Report (Exponent, 2004b), have been added to the "developed area" OU1 designation for this FS. The developed and undeveloped fill areas in this FS are designated as follows:

- **Developed Area**—This area is in the northern portion of the site and houses active industrial operations. This area is the general location of the original mercury processing facility. Figure 1-2 illustrates the developed area FS designation for OU1. The area is bounded to the north by various residential and commercial properties, to the west by Park Place East and a Conrail railroad line, to the southwest by a site designated as the Randolph Products property, and to the southeast by the undeveloped fill area (see below). The developed area consists of various warehousing operations (currently designated as the U.S. Life and Wolf Warehouses), a road to the north of those warehouses (Ethel Boulevard), a railroad track (Norfolk Southern spur), a small tract of land between Ethel Boulevard and the railroad tracks near Park Place East (designated as the EJB property), and industrial properties to the north of the railroad right-of-way (owned by Julius Blum and Company, Prince Packing Products, and Lin-Mor

Corporation).[1] Figure 1-2 illustrates each property within the OU1 FS boundary in the developed area. Building foundations occupy most of the developed area of the site. The rest of the developed area is covered by asphalt-paved surfaces (including Ethel Boulevard), the railroad tracks north of Ethel Boulevard, or a drainage ditch along the southwest side of the Wolf Warehouse. The railroad right-of-way to the north of Ethel Boulevard and the drainage ditch southwest of the Wolf Warehouse are the only areas within the developed area that are not currently capped with any impervious surface.

- **Undeveloped Fill Area—**This area, generally southeast of the developed area, was filled over time, but was not developed. The undeveloped fill area is bordered to the east by Berry's Creek (a tidally-influenced creek with a tide gate adjacent to the site), to the west by a ditch (designated as the West Ditch) adjacent to the Diamond Shamrock/Henkel property, the Randolph Products property, and the developed area; to the south by the Diamond Shamrock/Henkel (north) Ditch; and to the north by the railroad track that also crosses through the developed area. Figure 1-2 also illustrates the undeveloped fill area of OU1. The undeveloped fill area of the site is characterized by mixed vegetation and a variety of surficial debris. Much of this area is relatively flat, but the northeast portion of this area has uneven terrain. Another surface feature in the undeveloped fill area is a small basin generally south of the developed area, which is designated as a wetland. The area along the boundary of Berry's Creek and the Diamond Shamrock/ Henkel (north) Ditch has also been documented as wetlands (Shisler, 1997). The north and west perimeters of the area are fenced; additional fencing to the east prevents site access via the tide gate. Information in the easements for the properties suggests the potential presence of two drainage pipes that may have been installed in the undeveloped fill area between the developed area and Berry's Creek (see Figure 1-2 for general location, based on historical documentation). These pipes were not discovered during past remedial investigation efforts.

OU2, which is not included within the scope of this FS, consists of the portion of the site to the southwest of the undeveloped fill area and the adjacent marsh and water bodies, including Berry's Creek and Nevertouch Creek.

1.3 Site Background

Before 1929, most of the Wood-Ridge site was marshland. In 1929, F.W. Berk & Company, Inc. ("Berk") constructed and began operations as a mercury processing plant. The site housed mercury processing operations from approximately 1929 to 1974.

Various owners and operators occupied the site throughout the manufacturing history. Berk began operations as a mercury processing plant in 1929. Berk initially leased the land from the Carlstadt Development and Trading Company, but purchased the land in 1943. Between 1952 and 1955, the Magnesium Elektron Corporation leased a portion of the property. Ownership of the entire parcel was transferred to George W. Taylor following his

[1] Note that the developed area within the FS varies from the description of the developed area within the RI Report (Exponent., 2004b). The areas to the north of the existing warehouses (Ethel Boulevard, the railroad right-of-way, the Julius Blum property, the Prince Packing Property, and the EJB property) have been included as target areas within the OU1 FS as requested by NJDEP and USEPA in an April 23, 2004, letter (comment #8). In addition, the Lin-Mor Corporation property has been included as a target area within the OU1 FS based on concentrations of COCs greater than NJDEP's RDCSCC (see Appendix B). This designation of the developed area for OU1 will be continued throughout the remainder of the FS.

purchase of all of the outstanding shares of F.W. Berk & Company, Inc., in 1956. Operations continued under the Berk name until June 1960 when Taylor sold all of the assets and the business to Wood-Ridge Chemical Corporation (WRCC), a wholly-owned subsidiary of the Velsicol Chemical Corporation (Velsicol). Velsicol continued to operate the plant until 1968 through its WRCC subsidiary. In 1967, Velsicol's WRCC subsidiary declared a land dividend of the 33-acre undeveloped fill area to Velsicol. Ventron Corporation (Ventron) acquired WRCC from Velsicol in February 1968. Accordingly, Ventron owned only the approximately 7-acre parcel on which the plant was located; the 33-acre undeveloped portion remained the property of Velsicol. Ventron continued operations at the site until 1974. Upon the termination of operations, Troy Chemical Corporation acquired all of the plant's manufacturing assets but not the 7-acre portion of the site, which was sold to Robert and Rita Wolf. Velsicol retained ownership of the undeveloped 33-acre portion of the site until transferring ownership to NWI Land Management, Inc. (NWI) in 1986. NWI merged with Fruit of the Loom, which assumed liability for the site as a successor-in-interest to NWI. Upon the resolution of the Chapter 11 Bankruptcy of Fruit of the Loom, the 33-acre parcel was transferred to a Custodial Trust created as part of a settlement among Velsicol, NWI, Fruit of the Loom, the United States and State of New Jersey. Title was transferred to the Custodial Trust, by and through LePetomane III, Inc., not individually but solely in the representative capacity of Custodial Trustee under the Custodial Trust Agreement dated August 19, 2002 (Custodial Trust), which now holds title to the property.

In 1976, 2 years after Ventron sold the 7-acre parcel to Robert and Rita Wolf, Ventron was acquired by Thiokol Corporation ("Thiokol"). In 1982, Morton International, Inc. merged with Thiokol to form Morton Thiokol, Inc. Accordingly, the involvement of the company then known as Morton did not occur until eight years after the sale and demolition of the Wood-Ridge property. In 1989, a new entity was formed and named Morton International, Inc. Morton Thiokol, Inc. subsequently assumed the name Thiokol Corporation. In 1997, a new entity was formed. This New Morton International, Inc. was subsequently renamed Morton International, Inc. Thus, the company now known as Morton International, Inc. did not exist until 1997, and had no role in operating or decommissioning the facility and no ownership or other interest in either the 7-acre portion of the Site or the undeveloped fill area of the Site.

The operations at the mercury processing facility appear to be generally similar throughout its manufacturing history (ERM, 1985). Manufacturing processes included the following: the processing of elemental or prime virgin mercury (usually owned by the plant's customers) into inorganic mercury compounds (examples include red oxide of mercury, yellow oxide of mercury, and chlorides of mercury); cleaning of prime virgin mercury and dirty mercury into purer grades of mercury (such as reagent grade, triple distilled mercury); processing elemental mercury into organic mercury compounds (such as phenyl mercuric acetate); and processing and reclaiming mercury from waste materials, dental amalgam, batteries, and broken thermometers. The facility also resold prime virgin mercury, performed grinding and blending operations and engaged in the toll-manufacture of some non-mercurial products for customers.

Processing operations at the site generated mercury-bearing wastes streams. During Ventron's operation of the facility, production processes were changed to update technologies and significantly reduce the amount of mercury discharged in the wastewater effluent. For example, the treatment of mercury effluent from the primary settling tanks was redesigned during 1968 to use sodium borohydride. Ventron subsequently received a patent on this method for removing mercury from aqueous streams and a chemical engineering magazine recognized Ventron's achievement in developing this method. Because of Ventron's actions and process improvements, significant reduction occurred in regard to the facility's mercury discharge. (Testimony of Joseph H. Bernstein.)

Ventron employees reported that under prior management, solid wastes and ash residue from mercury recovery operations were disposed of on the undeveloped fill area of the site. In addition, there is evidence that the Borough of Wood-Ridge used the 33-acre portion of the site for municipal waste dumping (Exponent, 2004a). When Ventron took control in 1968, it discontinued the practice of onsite dumping and arranged for solid wastes to be drummed and disposed of offsite. Several methods were used to dispose of waste. Recycling of mercury thermometers resulted in large mounds of fused glass that was disposed of in the plant trash. Dental amalgam was returned to a silver recovery company. Silver battery casings were returned to battery manufacturers. Metal battery shells were disposed of in the facility's trash. Ash generated in the recovery of sludge was accumulated in 55-gallon drums and periodically taken by a disposal firm to a landfill. The facility would accumulate approximately one small load of 40 to 60 drums of this ash waste in 1 year.

Operations ceased on April 15, 1974, at which point no further process waste or wastewater was generated. As noted above, Ventron sold its manufacturing assets (other than real estate) to Troy Chemical Company, which removed the assets from the site. Ventron contracted with Gaess Environmental Services to remove mercury chemicals and mercury-bearing wastes, as well as materials in vats and collecting basins from the plant. Robert and Rita Wolf, also known as Wolf Reality Company, purchased the property in 1974. Wolf planned to demolish the existing facility and construct two warehouses on the 7-acre parcel. Before demolition of the buildings, the Wolfs had participated in several conversations with Ventron regarding the site and its former operations before taking ownership. WRCC's former Chief Chemist from the Wood-Ridge site recommended to the Wolfs precautions for the demolition of certain buildings. These precautions included removal of containers, sweeping of dust and debris from floors, and washing of ceilings, walls, and floors. In addition, WRCC's former Chief Chemist recommended that cleanup and demolition workers wear rubber rain-wear suits, rubber gloves, safety helmets, and facial respirators.

Before demolition, a representative of the New Jersey Department of Labor and Industry accompanied Robert Wolf, among others, on a survey of the site. A report from this survey indicates that Wolf was told to remove remaining equipment, containers, and sludges and wash down the buildings before commencing the demolition. The Wolfs did not perform the washing down or demolition activities with appropriate precautions, however, and on June 7, 1974, NJDEP conducted an investigation at the site and determined that as a result of hosing down the buildings and wetting the area during demolition, Rovic Construction Company, Inc. ("Rovic," which was owned by the Wolfs) was responsible for the discharge of hazardous chemicals and petroleum products onto site soil and into Berry's Creek.

Primary data reports of sampling conducted during and immediately after demolition of the facility have not been located. Results are summarized in various overview reports, including reports by David Lipsky (undated), Jack McCormick & Associates (JMA, 1977), and ERM (1985). These summaries are often repeated verbatim from one report to the next; supporting tables and documentation are often missing from these reports. Nevertheless, such summaries are the only information located that provides mercury levels in soil during this time. The JMA report notes that soil samples collected in 1972 contained mercury concentrations ranging from 5.0 to 375 milligrams per kilogram (mg/kg). The ERM report summarizes data from other sources, indicating soil samples collected in July 1974, after the washing of mercury from building structures across the soil and into Berry's Creek, contained mercury concentrations in the soil ranging from 185 to 3,215 mg/kg under the proposed footprint of Building No. 1 (currently known as U.S. Life Warehouse) and from 1,775 to 195,000 mg/kg beneath the proposed footprint of Building No. 2 (currently known as the Wolf Warehouse). Before the warehouses were constructed, a memorandum of understanding (MOU) was executed between USEPA, NJDEP, and Wolf regarding the conditions to be met. The MOU called for additional soil sampling and soil removal before construction of the U.S. Life Warehouse (Building No. 1) and further soil evaluation on the area where the Wolf Warehouse is now located. The U.S. Life Warehouse was constructed in 1974, with removal of the upper layer of contaminated soil and placement in the undeveloped fill area.

According to summaries contained in the ERM Report (ERM, 1985), in January 1975, Wolf submitted a multi-phased proposal for the encapsulation of contaminated mercury soil beneath the proposed Wolf Warehouse building. The plan included construction of a continuous perimeter footing in contact with the organic layer of soil (considered by Joseph S. Ward, Inc., the consulting geotechnical engineer at the time, to be impervious), construction of a shallow containment wall around the perimeter of the eastern and southern property lines, complete impervious paving of the surface, and construction of water-impervious ditches for drainage from the site. Negotiations between USEPA and the Wolfs continued until 1975 without full resolution of all issues. In 1975, construction of the Wolf Warehouse began. Soil containing elevated mercury concentrations remained in place beneath the warehouse, with the combination of paving, containment wall, and warehouse flooring serving to encapsulate this soil. The location and extent of the containment wall was assessed during the Phase IA RI investigation (Exponent, 1998). The containment wall was found in only two of five locations tested and is, therefore, assumed to be discontinuous.

Since that time, various parties have owned the properties within the OU1 FS boundary. Details of the ownership of each lot and block within OU1, based on local tax records, are included in Table 1-1 and Figure 1-2.

1.4 Site Geology, Hydrogeology, and Hydrology

1.4.1 Site Geology

The site is located in the Newark Basin, which contains sedimentary rock consisting of primarily sandstone and shale and layered with igneous rocks. Based on previous geotechnical studies, the geologic units at the site are as follows (increasing with depth):

- **Fill material**, which was placed in the entire area that was previously marsh. There appears to be two distinct areas of fill material, based on the current usage of the areas. The undeveloped fill area was filled with surficial fill, consisting of gravel, sand, silt, and clay, with shale fragments as well as glass, brick, cinders, porcelain, wire, leather, cloth, coal, chemical matter, wood, shingles, rubber, plastic, metal, and other debris. In the undeveloped fill area, fill thickness ranges from approximately 3 to 14 feet. Surficial fill in the developed area consists of predominantly silt and clay, with limited sand and gravel. The fill in the developed area ranges in thickness from approximately 5 to 8 feet. Based on site data, it appears that fill material was placed in the developed area before construction of the existing warehouses, and also included the disruption of a majority of the meadow mat (below).
- **Meadow mat,** consisting of fibrous organic peat and silt, which, if present, ranges from 0.5 to 4 feet thick. The meadow mat is thinner beneath the undeveloped fill area where artificial filling has occurred, which may indicate the meadow mat in this area has been compressed by the overlying fill. The meadow mat appears to have been disrupted in the vicinity of the U.S. Life and Wolf Warehouses, and is generally absent in the northwest portion of the undeveloped fill area adjacent to the warehouses.
- **Fine to medium-grained sand,** approximately 5 to 10 feet thick.
- **Gray to red-brown silt,** approximately 62 to 146 feet thick.
- **Red-brown silty sand,** at least 20 feet thick.
- **Bedrock,** consisting of reddish-brown shale, siltstone, and sandstone within the Passaic Formation. The approximate thickness of bedrock in this portion of the Passaic Formation is approximately 9,000 feet (Lytle and Epstein, 1987).

Previous geotechnical studies of the site (J.S. Ward, 1974, 1975) indicate the unconsolidated units at the site are consistent with those described in the region. These units are also described in more detail in the RI Report, Section 3.3 (Exponent, 2004b) and the Background Investigation Technical Memorandum (BITM), Volume 4 (Exponent, 2004b).

1.4.2 Site Hydrogeology

Groundwater is present on the site at depths ranging from approximately 2 to 8 feet below ground surface (bgs) within the surficial fill unit (Exponent, 1998) and generally flows to the south, toward Berry's Creek. A generally radial flow pattern (outward from the center) is, however, apparent in the undeveloped fill area. This is most likely caused by higher infiltration of water in the undeveloped fill area than in the areas to the north and west of the undeveloped fill area. Because of this mound in the undeveloped fill area, groundwater in the developed area flows generally north to south and then turns to the west-southwest as it meets the radial flow from the undeveloped fill area. As part of the overall radial flow patterns, groundwater in the eastern and southern portions of the undeveloped fill area flows toward Berry's Creek and the Diamond Shamrock/Henkel (north) Ditch.

The groundwater hydraulic gradients appear to be relatively flat over much of the site. Along the Diamond Shamrock/Henkel (north) Ditch and Berry's Creek as far upstream as the tide gate, the gradients close to the ditch/creek banks appear to be relatively steep.

Along Berry's Creek upstream of the tide gate, however, the gradients appear to be much flatter. This change in gradient may be because of the influence of the tide gate on the mean water surface elevation in Berry's Creek, and the subsequent influence of the surface water elevation on the groundwater surface elevation near the creek. Based on measurements during the tidal study (Exponent, 2004b), the mean water surface in Berry's Creek upstream of the tide gate is about 2 feet lower than downstream of the tide gate.

Based on results of tidal studies in the area, groundwater surface elevations fluctuate above and below mean sea level with tidal fluctuations. This relationship between the groundwater and surface water surface elevations indicates groundwater from the site discharges toward Berry's Creek at all times during the tidal cycle, including times when the surface water elevation is higher than groundwater. There is likely to be bank storage of infiltrating surface water between the creek and the monitoring wells used during the tidal study that would cause localized variations of flow direction at the fringe of the creek, however (Exponent, 2004b).

1.4.3 Surface Water Hydrology

Surface water drainage at the site is generally to the southeast, where Berry's Creek borders the site. In the developed area, which is mostly paved, drainage is generally directed toward the drainage ditch southwest of the existing warehouses. This ditch then flows along the West Ditch toward the Diamond Shamrock/Henkel (north) Ditch. Drainage in the developed area of the site is poor and there are locations of standing water surrounding the warehouse areas, which rise and fall with high and low tides. The West Ditch and the Diamond Shamrock/Henkel (north) Ditch are both tidally influenced and have water level fluctuations as much as 4 to 6 feet (at the confluence of the Diamond Shamrock/Henkel [north] Ditch and Berry's Creek).

In the undeveloped fill area, there are no well-defined drainage patterns. Drainage from the undeveloped fill area flows toward the West Ditch and toward the Diamond Shamrock/ Henkel (north) Ditch. The Diamond Shamrock/Henkel (north) Ditch flows in a southeasterly direction into Berry's Creek. Additional details on the surface water hydrology are provided in Section 3.5 of the RI Report (Exponent, 2004b).

1.5 Nature and Extent of Contamination

As presented in the RI, various compounds have been detected in soil, groundwater, surface water, and sediment at the site during the various phases of investigation. Mercury is the primary COC at the site, and has been detected in both soil and groundwater in OU1 at concentrations that exceed the applicable NJDEP cleanup criteria, Federal maximum contaminant limits (MCLs), and calculated risk estimates using conservative assumptions. The highest concentrations of mercury seen in soil are located beneath the former mercury processing facility (the current warehouse areas) and in an isolated area in the undeveloped fill area (see description of the high levels of mercury beneath the warehouses as discussed in Section 1.3 above). In groundwater, the highest concentrations of mercury are seen in the developed area, consistent with the locations of highest soil concentrations.

Other compounds, such as specific polycyclic aromatic hydrocarbons (PAHs), metals, and volatile organic compounds (VOCs), have also been detected in soil and groundwater in

OU1. Based on the widespread low levels of some of these compounds, however, and their locations and depths (mostly seen in the undeveloped fill area), it is believed that many of these compounds are indicative of fill material or background conditions. Below is a discussion of the compounds detected in soil and groundwater and justification for the list of COCs that will be used as the basis for the remedial alternatives within this FS.

1.5.1 Soil

Based on various phases of investigation, it has been determined that soil at the site within the OU1 boundary, both in the developed area and the undeveloped fill area, has been impacted with various compounds at concentrations exceeding the New Jersey Residential Direct Contact Soil Cleanup Criteria (RDCSCC) and the Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC). The 15 compounds exceeding the RDCSCC and NRDCSCC in soil (both surface and subsurface) within OU1 are:

- Mercury
- Arsenic
- Copper
- Beryllium
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Bis(2-ethylhexyl)phthalate
- Chrysene
- Dibenz (a,h)anthracene
- Indeno(1,2,3-cd)pyrene
- Lead
- Thallium
- Zinc

Since many of the compounds detected in soil are usually indicative of historic fill material and/or background, an evaluation was completed to determine if these compounds may be related to the fill placed at the site or background conditions, rather than historical site operations. This evaluation was important to define the COCs for soil within OU1 and to establish remedial target areas and applicable remedial technologies for these COCs.

To determine if the compounds detected in soil are related to fill material or background concentrations, the concentrations of the compounds listed above were compared to the NJDEP established values for historic fill material (*New Jersey Administrative Code* [N.J.A.C.] 7:26E-4, Table 4-2) and background (*A Summary of Selected Soil Constituents and Contaminants at Background Locations in New Jersey,* NJDEP, September 1993). Of the compounds listed above (excluding mercury), four (copper, bis[2-ethylhexyl]phthalate, chrysene, and thallium) are not listed as constituents seen in fill material and/or background. For the remaining compounds, the average concentrations of surface soil samples, subsurface soil samples, and all soil samples (surface and subsurface) are presented in Table 1-2. The NJDEP published values for contaminant concentrations in fill material (Table 4-2 of N.J.A.C. 7:26E, including both average and maximum values) and the concentrations for background concentrations (arithmetic mean values for urban areas, as defined in Table 9 of *A Summary of Selected Soil Constituents and Contaminants at Background Locations in New Jersey,* [NJDEP, September 1993]) are also included in Table 1-2.

As seen in Table 1-2, the concentrations of PAHs listed for both surface and subsurface soil are near or below the NJDEP published values for contaminated fill material. In surface soil, benzo(b)fluoranthene was the only PAH that exceeded the average historic fill values. Zinc, lead, and arsenic also exceeded the average historic fill values in surface soil. Benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene were the PAHs detected slightly above the average historic fill values in subsurface soil. These concentrations are only slightly over the published average values and are much lower than the published maximum values. Metals zinc, beryllium, lead, and arsenic were also seen slightly over the average historic fill values in subsurface soil; however, these concentrations are much lower than the maximum historic fill concentrations. Zinc concentrations exceeding the RDCSCC were only seen sporadically in soil samples (five locations at estimated concentrations in surface soil).

Based on these data, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, zinc, and beryllium will not be considered COCs within the FS. Note, however, that in accordance with NJDEP requirements, presumptive remedies for this historic fill material (N.J.A.C. 7:26E-6.2(c)) will be considered during the evaluation of soil alternatives.

When comparing the average concentrations in surface and subsurface soil for lead and arsenic, the data do not conclusively show that these compounds are related to fill material, since the average concentrations of these compounds vary with depth. These compounds were, therefore, retained for further evaluation to determine if they should remain as COCs for soil.

For the four remaining compounds not listed in the NJDEP tables (copper, bis[2-ethylhexyl]phthalate, chrysene, and thallium), lead, and arsenic, the following is a summary of the additional evaluation completed to determine if these compounds should be retained as COCs for the FS:

- **Copper—**Copper was detected over the RDCSCC at six sample locations (three surface and three subsurface samples). Of the sample results, five of the six were estimated concentrations. The areas with exceedances were sporadic and at varying depths. Since this compound was not reportedly used in site operations, it will not be listed as a COC in the FS. All of the alternatives presented in Section 4 will, however, address the potential presence of low-level copper contamination in isolated locations in soil.
- **Bis[2-ethylhexyl]phthalate—**This compound only exceeded the RDCSCC and NRDCSCC at two surface locations (SS-18 and SS-24). The results of all other surface and subsurface soil samples were below the RDCSCC. These two locations are not within the area of original site operations (the samples were located in the middle of the undeveloped fill area). Since this compound was not used in site operations and was not seen consistently over the site, it is believed that it is not a COC and that it is also related to fill material. All of the remedial alternatives presented in Section 4 will, however, consider that this compound is potentially present and related to historic fill material.
- **Chrysene—**As with bis(2-ethylhexyl)phthalate, chrysene was only seen at one discrete location (SS-29) in excess of the RDCSCC. The concentration of this compound at location SS-29 was, however, below the NRDCSCC. When comparing this to the sample results surrounding this location, it is apparent that this sample result is an outlier. Along with the fact that this compound was not used in site operations and is not near historic facility operations, this compound will not be considered as a COC within this FS. As with copper and bis(2-ethylhexyl)phthalate, however, this exceedance of chrysene will be considered when developing and evaluating alternatives for site soil.

- **Thallium—**There were only two surface soil sample exceedances and three subsurface soil exceedances of the RDCSCC for thallium (SS-08 and SS-20 in shallow soil and TP-3, TP-4, and TP-5 in subsurface soil). As with the other compounds discussed above, it is believed that the compound was not related to site operations and is not within the operational areas of the site. The sample locations are sporadic and do not consistently show exceedances of the RDCSCC over the undeveloped fill area. Because of this, thallium will not be considered as a soil COC within the FS. The soil alternatives presented in Section 4 will, however, take into consideration the potential presence of thallium in soil.
- **Lead—**As stated above, the concentrations of lead were seen in soil at concentrations higher than the NJDEP published average values for historic fill material, but well below maximum values. The data suggest, however, that subsurface soil may have higher concentrations of lead than surface soil. These data suggest that the lead is not related to fill materials, since it would be expected that no significant difference in concentrations would be seen with depth. In addition, the highest level of lead was detected in the undeveloped portion of the site. Lead was, therefore, retained as a soil COC within the FS. When comparing the results of the soil and defining the area with concentrations of lead over the RDCSCC, it is apparent that the area exceeding the PRG is within the footprint of the mercury target area.
- **Arsenic—**Arsenic in both surface and subsurface soil was detected at concentrations exceeding the NJDEP published average values for historic fill material, but well below the maximum values. When comparing the results of surface soil versus subsurface soil, however, the concentrations of arsenic in surface soil were detected at higher concentrations, on average, than in subsurface soil. These data suggest the arsenic is not related to filled materials, since it would be expected that no significant difference in concentrations would be seen with depth; therefore, arsenic was retained as a soil COC within the FS. When comparing the results of this soil and defining the area with concentrations of arsenic over the RDCSCC, it is apparent that the area exceeding the PRG is within the footprint of the mercury target area.

1.5.2 Groundwater

As presented in the RI, a number of compounds were detected in groundwater at the site between 1990 (during a NJDEP sampling event) and 2002. Samples have also been collected in site monitoring wells in 1997, 1999, and 2000. Compounds that have exceeded the New Jersey Groundwater Quality Criteria (GWQC)[2] during at least one sampling event are as follows:

- Mercury
- Arsenic
- Cadmium
- Iron
- Lead
- Manganese
- Nickel
- Thallium
- Benzene
- Toluene
- Xylenes (total)
- 1,2-dichloroethene (1,2-DCE)

Based on the original site operations, the contaminants detected in soil, and the operational areas at the facility, it is believed that many of these compounds are either not related to site

[2] Note that chlorobenzene exceedances of the GWQC in groundwater were documented in the RI Report (Exponent, 2004b). The concentrations of chlorobenzene in groundwater exceeded the Groundwater Quality Standards (N.J.A.C. 7:9-6) of 4 μg/L, but are below the established interim specific groundwater quality criterion of 50 μg/L; therefore, they are not listed as a COC within the FS.

operations or are background concentrations in groundwater. The following provides a justification for the inclusion or elimination of specific compounds (except mercury) as COCs for groundwater.

- **Arsenic—**Arsenic has been detected at four locations exceeding the GWQC (MW-6, MW-13, MW-14, and MW-15) since groundwater sampling was initiated in 1990. In 2002, three monitoring wells had exceedances of arsenic over the GWQC (MW-6, MW-13, and MW-15). The monitoring wells that have exceeded the GWQC for arsenic have generally surrounded the developed area (specifically the Wolf Warehouse) and immediately downgradient. Based on the evaluation of soil contamination, it was also concluded that arsenic was a soil COC; therefore, arsenic was retained as a COC for groundwater in the FS.

- **Cadmium—**Cadmium was detected at only one location exceeding the GWQC (MW-5 at a concentration of 5.7 μg/L) in 1999. When sampled in 2002, cadmium was detected at concentrations below the GWQC. This isolated sample result is the only sample that has demonstrated an exceedance of the GWQC for cadmium. It is proposed, therefore, that cadmium not be included as a site COC in groundwater. Note that all the groundwater alternatives will take into consideration the potential presence of cadmium in groundwater; however, cadmium will not be used as a COC to determine the most appropriate groundwater remedial alternative.

- **Iron—**Iron has been detected in all site monitoring wells exceeding the GWQC since initiation of sampling by NJDEP in 1990; however, sampling methods (filtered, unfiltered, and low-flow sampling) have varied between sampling events. The concentrations of iron have been detected over the entire site, both in upgradient and downgradient wells, and have not varied significantly over the site or over time. It is believed, therefore, that iron is related to background geochemical conditions and not site operations. Note that all the groundwater alternatives will take into consideration the presence of iron in groundwater; however, iron will not be used as a COC to determine the most appropriate groundwater remedial alternative.

- **Lead—**Lead was detected at only one location exceeding the GWQC (MW-15 at a concentration of 13.9 μg/L) in 1999. When sampled in 2002, lead was detected below the GWQC at every well. This isolated sample result is the only sample that has demonstrated an exceedance of the GWQC for lead; therefore, it is proposed that lead not be included as a site COC in groundwater. Note that all the groundwater alternatives will take into consideration the potential presence of lead in groundwater, but lead will not be used as a COC to determine the most appropriate groundwater remedial alternative.

- **Manganese—**Manganese has also been detected in all site monitoring wells exceeding the GWQC since initiation of sampling by NJDEP in 1990. Sampling methods (filtered, unfiltered, and low-flow sampling) have varied, however, between sampling events. The concentrations of manganese have been detected over the entire site, both in upgradient and downgradient wells, and have not varied significantly over the site. It is believed, therefore, that manganese is related to background geochemical conditions and not site operations. Note that all the groundwater alternatives will take into consideration the presence of manganese in groundwater, but manganese will not be used as a COC to determine the most appropriate groundwater remedial alternative.

- **Nickel—**Nickel was detected at only one location exceeding the GWQC (MW-6 at a concentration of 115 μg/L) in 1997. When sampled in 1999 and 2002, nickel was detected below the GWQC. This isolated sample result is the only sample that has demonstrated an exceedance of the GWQC for nickel; therefore, it is proposed that nickel not be included as a site COC in groundwater. Note that all the groundwater alternatives will take into consideration the potential presence of nickel in groundwater, but nickel will not be used as a COC to determine the most appropriate groundwater remedial alternative.

- **Thallium—**Thallium was detected at only one location exceeding the GWQC (MW-2 at a concentration of 13.5 μg/L) in 1999. When sampled in 2002, thallium was detected below the GWQC. This isolated sample result is the only sample that has demonstrated an exceedance of the GWQC for thallium; therefore, it is proposed that thallium not be included as a site COC for groundwater. Note that all the groundwater alternatives will take into consideration the potential presence of thallium in groundwater, but it will not be used as a COC to determine the most appropriate groundwater remedial alternative.

- **Benzene—**Since groundwater sampling has been initiated, benzene has been detected over the GWQC in various monitoring wells. The concentrations of benzene exceeding the GWQC have varied from 140 μg/L (MW-2 in 1997) to 2.5 μg/L (MW-8 in 2002). When comparing the benzene results from samples collected near the Wolf Warehouse (MW-7, MW-8, MW-9, MW-13, and MW-15) to sample results upgradient of that area (MW-10 and MW-11), however, the concentrations of benzene near the Wolf Warehouse are higher than upgradient sample results. Benzene was, therefore, retained as a COC for groundwater within the FS.

- **Toluene—**Toluene was detected at only one location exceeding the GWQC (MW-2 at a concentration of 1,700 μg/L) in 1997. When sampled in 1999, toluene was detected below the GWQC at all wells. This isolated sample result is the only sample that has demonstrated an exceedance of the GWQC for toluene. It is proposed, therefore, that toluene not be included as a site COC in groundwater. Note that all the groundwater alternatives will take into consideration the potential presence of toluene in groundwater, but it will not be used as a COC to determine the most appropriate groundwater remedial alternative.

- **Xylenes (Total)—**Xylenes (total) were detected at only one location exceeding the GWQC (MW-2 at a concentration of 390 μg/L) in 1997. When sampled in 1999, total xylenes were detected below the GWQC at all locations. This isolated sample result is the only sample that has demonstrated an exceedance of the GWQC for total xylenes. It is proposed, therefore, that xylene not be included as a site COC for groundwater. Note that all the groundwater alternatives will take into consideration the potential presence of xylenes in groundwater, but xylenes will not be used as a COC to determine the most appropriate groundwater remedial alternative.

- **1,2-DCE—**1,2-DCE was detected at only one location exceeding the GWQC (MW-9 at a concentration of 45 μg/L) in 1997. When sampled in 1999, 1,2-DCE was detected below the GWQC. This isolated sample result is the only sample that has demonstrated an exceedance of the GWQC for 1,2-DCE; therefore, it is proposed that 1,2-DCE not be included as a site COC for groundwater. Note that all the groundwater alternatives will take into consideration the potential presence of 1,2-DCE in groundwater, but it will not be used as a COC to determine the most appropriate alternative.

1.5.3 Summary of COCs

Table 1-3 presents the summary of the COCs that will be evaluated within the FS. For soil, the COCs are mercury, arsenic, and lead. In groundwater, the COCs are mercury, arsenic, and benzene. Note that the COCs listed within Table 1-3 are the COCs that are the focus of the remedial alternatives presented in Section 4. Each of the alternatives evaluated in Sections 4 and 5, however, also take into consideration other compounds that may be present in soil and groundwater related to historic fill or background conditions that may impact alternative effectiveness for treatment of the COCs.

1.6 Summary of Human Health and Ecological Risks

In April 2001, January 2004, and March 2005, the baseline human health risk assessment (HHRA) was submitted to NJDEP and USEPA (Exponent, 2001b, 2004a, and 2005). The purpose of the baseline HHRA was to evaluate potential human health risks related to the chemicals remaining at the site in the absence of active remedial actions. Exposure pathways evaluated included contact (i.e., ingestion and dermal contact) with surface and subsurface soil, sediment, and surface water; contact with groundwater; and inhalation of outdoor air and indoor air potentially impacted by volatilization of chemicals from subsurface soil or groundwater.

Evaluation of hypothetical residential future consumption of drinking water resulted in a cancer risk estimate greater than the upper end of the target risk range (i.e., 1×10^{-4}), primarily related to arsenic and benzene in groundwater. All other pathways were within the target risk range of 1×10^{-4} to 1×10^{-6}. Non-cancer risk indexes greater than the target of 1 were identified for the following exposure pathways:

- Contact with surface soil (assuming all pavement was removed) or subsurface soil in the developed area
- Contact with surface or subsurface soil in the undeveloped fill area
- Inhalation of contaminants volatilized from surface soil in the undeveloped fill area
- Consumption of drinking water or inhalation of volatile constituents from drinking water by either hypothetical future workers or residents

The RAOs and remedial alternatives for soil and groundwater presented in this FS take into consideration eliminating these potential pathways.

1.6.1 Ecological Risk Assessment

In April 2001, a draft ecological risk assessment (ERA) was submitted for OU1 (Exponent, 2001a). Comments were provided by NJDEP and USEPA in August 2003. The purpose of the ERA was to evaluate potential risks to ecological receptors from site-related contaminants assuming no remedial actions would be implemented. The results of the ERA were summarized in the November 2003 Tech Memo (Exponent, 2003). The NJDEP and USEPA will make a decision about the acceptance of the ERA pending their review of various other deliverables.

The ERA assessed potential risks to ecological receptors from exposure to groundwater, surface soil in the undeveloped area, and surface water and sediment in the onsite basin and the West Ditch based on baseline conditions prior to any remediation. Maximum contaminant concentrations exceeded screening values in all media. The primary contaminant of concern is mercury, although other contaminants, notably chromium, lead, and zinc, are also potentially problematic. Refinement of the risk estimates (e.g., comparison to alternate screening benchmarks) still resulted in exceedances in all media except groundwater. Food chain models for top predators, consumers of soil invertebrates (e.g., earthworms), and consumers of fish and aquatic benthos indicated potential risks to all but the top predators; however, the food chain model for the top predators contains significant uncertainty concerning the estimation of contaminant concentrations in small mammal prey. Overall, the ERA found that a number of contaminants, notably mercury, in surface soil, sediment, and surface water pose risk to ecological receptors. Of potential risks, those to benthic invertebrates, other aquatic life, and earthworm predators such as the shrew and woodcock appear to be the most significant and most likely.

2 Development and Identification of ARARs, RAOs, and PRGs

2.1 Summary of ARARs

Remedial actions must be protective of human health and the environment. Section 121 of CERCLA requires that primary consideration be given to remedial alternatives that attain or exceed ARARs. The purpose of this requirement is to make CERCLA response actions consistent with other pertinent federal and state environmental requirements, as well as to adequately protect human health and the environment.

Definitions of the ARARs and the "to be considered" (TBC) criteria are as follows:

- Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, environmental action, location, or other circumstance at a CERCLA site.
- Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law, which while not "applicable," address problems or situations sufficiently similar (relevant) to those encountered at a CERCLA site, that their use is well suited (appropriate) to the particular site.
- TBC criteria are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing an interim remedial action, or are necessary for evaluating what is protective of human health and/or the environment. Examples of TBC criteria include the NJDEP Soil Cleanup Criteria, USEPA Drinking Water Health Advisories, Reference Doses, and Cancer Slope Factors.

ARARs are grouped into three types: chemical-specific, action-specific, and location-specific. Included in Appendix A are the chemical-specific, action-specific, and location-specific ARARs for the site.

2.1.1 Chemical-Specific ARARs

Chemical-specific ARARs include laws and requirements that establish health- or risk-based numerical values or methodologies for environmental contaminant concentrations or discharge. The chemical-specific ARARs for the site can be classified into three categories: (1) residual concentrations of compounds that can remain at the site without presenting a threat to human health and the environment, (2) land disposal restriction (LDR) concentrations that must be achieved if the contaminated media contains a characteristic hazardous waste or contains a listed hazardous waste is excavated or extracted and later land disposed, and

(3) effluent concentrations that must be achieved in treatment of groundwater for discharge to surface water or groundwater. These three classifications are discussed below.

2.1.1.1 Residual Concentrations

TBCs for residual soil concentrations include the New Jersey Soil Cleanup Criteria (combined Tables 3-2 and 7-1 from NJDEP's February 3, 1992, proposed rule titled Cleanup Standards for Contaminated Sites N.J.A.C. 7:26D), which includes the RDCSCC, the NRDCSCC, and the Impact to Groundwater Soil Cleanup Criteria (IGWSCC). Since the NJDEP Soil Cleanup Criteria are not promulgated, they are considered TBCs rather than ARARs. USEPA Region 9 PRGs are considered to be TBCs for the site.

For groundwater, the NJDEP GWQC - (N.J.A.C. 7:9-6), the Safe Drinking Water Act (SDWA) MCLs, and the New Jersey Secondary Drinking Water Standards (N.J.A.C. 7:10-7) are ARARs for residual concentrations.

2.1.1.2 LDR Considerations

Wastes generated by the remediation of the Site must be properly characterized and managed in accordance with the requirements of the Resource Conservation and Recovery Act (RCRA). Environmental media, such as impacted soils, sediments, or debris, may be hazardous either if it is or contains a listed hazardous waste, or if it exhibits a hazardous waste characteristic.

To determine whether a hazardous waste listing applies, it is generally necessary to have information about the source of the waste. The following information indicates that the wastes generated by the remediation at the Site do not contain listed hazardous waste:

1. USEPA has noted that "at many CERCLA sites no information exists on the source of the wastes nor are references available citing the date of disposal." 53 Fed. Reg. 51444 (December 21, 1988). The Site was decommissioned and demolished in 1974; therefore, soils became impacted by mercury due to facility operations prior to the passage of the Resource Conservation and Recovery Act in 1980. Accordingly, at the time soils may have been impacted, no listed wastes were managed at the Site.

2. The next question is whether the impacted soils will "contain" a listed waste at the time they are "generated" through active management or excavation of the impacted soils. Two listings address mercury-containing wastes. The first, K106, is defined as "wastewater treatment sludge from the mercury cell process in chlorine production" (40 CFR § 261.32). The Wood-Ridge facility did not produce chlorine, so this listing is inapplicable to wastes generated at the Site. The second listing, U151, is elemental mercury as a "commercial chemical product" that is disposed (40 CFR § 261.33). Although the facility handled elemental mercury in product form as a raw material, it also handled mercury in the form of products, process materials, mixtures, and waste streams, none of which can be characterized as U151.

3. USEPA provides guidance (*Management of Remediation Waste Under RCRA,* USEPA 1998) regarding how to determine if environmental media contains a listed hazardous waste:

> "Where a facility owner/operator makes a good faith effort to determine if a material is a listed hazardous waste but cannot make such a determination because documentation regarding a source of contamination, contaminant, or waste is unavailable or inconclusive, EPA has stated that one may assume the source, contaminant or waste is not listed hazardous waste and, therefore, provided the material in question does not exhibit a characteristic of hazardous waste, RCRA requirements do not apply…"

As discussed above, raw materials used at the facility included the following:

- Elemental or prime virgin mercury, which was processed into inorganic and organic mercury compounds;
- Prime virgin mercury and various types of "dirty" mercury, which was refined into purer grades of mercury; and
- Mercury from waste materials, such as dental amalgam, sludges, batteries, and broken thermometers, which was recovered and returned to the customer or further processed.

The waste streams generated by the mercury processing facility included wastewater, wash water, and other aqueous streams, ash residue from retorting, fused glass and metal battery casings from mercury recovery, and other residues.

In accordance with the USEPA 1998 guidance, because the source of mercury in the media could have come from the release of raw material, process material, finished product or waste and therefore cannot be conclusively determined, neither the environmental media nor remediation wastes generated from the handling of that media will be deemed to be or to contain listed hazardous waste.

Mercury impacted soil may also be a hazardous waste if it exhibits a hazardous characteristic. Exhibited hazardous characteristics include ignitability, corrosivity, reactivity, or toxicity (i.e., Table 1 Constituents based on the Toxicity Characteristic Leaching Procedure, TCLP) as determined by laboratory testing (40 CFR §§ 261.21 – 261.24). For mercury, if the TCLP of the impacted soils contains mercury at a concentration exceeding 0.20 mg/L, the waste will be characteristic hazardous waste D009.

If mercury-impacted soils exhibit a hazardous waste characteristic when they are "generated" by being excavated or managed, the soils must be managed as a hazardous waste and must meet applicable Land Disposal Restriction (LDR) treatment standards for hazardous waste containing mercury before they can be land disposed. Although treatment standards for waste streams designated D009 include designated technologies involving thermal processing either by retorting or roasting, these standards were established for industrial wastes that are reasonably consistent in composition and can be treated by thermal treatment. USEPA has specifically recognized that soils containing historic contamination are different from "as-generated" waste, because contaminated soils present practical problems due to variation in composition and treatment technological issues, and that such contaminated soil should therefore not be subject to the same treatment standards. Therefore, there are two alternative methods for complying with LDR requirements for mercury-impacted soils.

First, a variance procedure exists for addressing contaminated media, where the treatment standard is impractical or inappropriate, or where there is no appropriate treatment capacity (40 CFR § 268.44). The variance procedure provides that a generator of a hazardous waste may apply to the USEPA Administrator (or to the Director of an authorized state) for a variance from an applicable treatment standard under the LDR regulations. This site-specific variance may be approved if it is not physically and technologically possible to treat the waste to the level specified in the treatment standard, or by the method specified as the treatment standard, or that it is inappropriate to use the treatment standard or method due to technical or practical problems. Many remedial actions in the past involving mercury-contaminated soils have relied on this variance procedure to authorize stabilization and landfilling in a hazardous waste landfill, where stabilization is an appropriate technology for the particular remediation wastes at issue.

Alternatively, impacted soils may be treated to the Alternative LDR Treatment Standards for Contaminated Soil. 40 CFR § 268.49. The alternative LDR treatment standards require that the contaminated media must be treated in a manner to achieve all of the following:

1. For non-metals, treatment must achieve 90% reduction in total concentrations, except as described in 3 below. Since the soil from the Site potentially is hazardous waste characteristic (D009), the soil must be treated for all constituents subject to Universal Treatment Standards (UTS) ;
2. For metals, treatment must achieve 90% reduction in constituent concentrations as measured in leachate from the treated media or 90% reduction in total constituent concentrations (when a metal removal technology is used), except as provided in 3 below:
3. When treatment of any constituent subject to treatment to a 90% reduction standard would result in a concentration less than 10 times the UTS for that constituent (10 x 0.025 mg/L for non-retorted mercury waste), treatment to achieve constituent concentrations less than 10 times the UTS is not required.

The UTS for mercury-impacted soil (D009 waste), as specified in 40 CFR 268.48, is:

- Mercury – non-wastewater from retort – 0.20 mg/L TCLP
- Mercury – all others – wastewater 0.15 mg/L; non-wastewater standard 0.025 mg/L TCLP

Accordingly, contaminated soils meeting either the 90% reduction or the 10 times the UTS for the constituent in question may be land disposed. Contaminated soils treated to 10 times the UTS for non-wastewaters from sources other than retort is 0.25 mg/L TCLP for mercury, just above the hazardous waste characteristic level. Soil residuals from treatment in accordance with the alternative soil treatment standard may be land disposed, but if they exceed 0.20 mg/L TCLP, they must be disposed in a hazardous waste landfill. If the treatment residuals are below 0.20 mg/L TCLP, they are not characteristically hazardous waste and meet the alternative LDR treatment standard, and accordingly may be disposed in a non-hazardous waste landfill.

40 CFR 268.49(e) requires that treatment residues also be managed in accordance with the LDRs. For example, "soil residuals," such as fines and sludge from soil washing operations

that fail the TCLP for mercury, must be managed in accordance with the soil LDR requirements described above. Non-soil residuals, such as wash water that fails TCLP for mercury, must be managed in accordance with the treatment standards for that waste code (i.e., must be treated to the D009 LDR, rather than the 10 times the UTS LDR concentration for mercury).

2.1.1.3 Effluent Standards

For water generated during remedial actions, specific groundwater discharge requirements are necessary for the disposal of water after treatment. The two main effluent standards that are applicable, as established by NJDEP, are:

- **Discharge to Groundwater—**Involves re-injection of treated groundwater to the aquifer. The discharge to groundwater limit in all Class 2A waters in New Jersey is 2.0 μg/L for mercury, 1.0 μg/L for benzene, and 0.02 μg/L for arsenic. NJDEP will require a New Jersey Pollutant Discharge Elimination System (NJPDES) Discharge to Groundwater Permit (N.J.A.C. 7:14A-7) to allow for a discharge to groundwater.
- **Discharge to Surface Water—**Involves the discharge of groundwater to a surface water body after treatment. The surface water quality standard effluent limit for mercury into Berry's Creek is 0.144 μg/L. NJDEP will require an NJPDES Discharge to Surface Water Permit (N.J.A.C. 7:14A-11 through 13) to allow for a discharge to surface water.

2.1.2 Action-Specific ARARs

Action-specific ARARs regulate the specific type of action or technology under consideration, or the management of regulated materials. The most important federal action-specific ARAR that may affect the RAOs and the development of remedial action alternatives is RCRA. RCRA regulations governing the identification, management, treatment, storage, and disposal of solid and hazardous waste would be ARARs for alternatives generating waste that would be moved to a location outside the area of contamination. Requirements include waste accumulation, record keeping, container storage, manifesting, transportation, and disposal. As discussed above, soil at the site may be a characteristic hazardous waste. If the soil is a characteristic hazardous waste, RCRA LDRs would apply and treatment would be required in accordance with RCRA before disposal. This also includes treatment of other underlying hazardous constituents as required by 40 CFR 268.9(a).

There are also specific state requirements, such as the *Technical Requirements for Site Remediation* (N.J.A.C. 7:26E), and other applicable state regulations that are action-specific ARARs for the site.

2.1.3 Location-Specific ARARs

Location-specific ARARs are requirements that relate to the geographical position of the site. State and federal laws and regulations that apply to the protection of wetlands, construction in floodplains, and protection of endangered species in streams or rivers are examples of location-specific ARARs. Location-specific ARARs that may be applicable to the remedial activities, depending on the remedial action selected are:

- Coastal Area Facility Review Act Permit (N.J.S.A. 13:19-1 et seq.)
- Waterfront Development/Upland Waterfront Permit (N.J.S.A. 12:5-3)
- Wetlands Permit (N.J.S.A. 13:9A-1)
- Freshwater Protection Act (N.J.S.A. 13:9B-1)
- Stream Encroachment Permit (Construction Within a Flood Plain) (N.J.S.A. 58:16A-50 et seq.; N.J.A.C. 7:8-3.15)
- New Jersey Meadowlands Commission—Zoning Certificate (N.J.S.A. 13:17-1 et seq.)

2.2 Remedial Action Objectives

The USEPA *Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites* (USEPA, 1988a) and the NCP define RAOs as medium-specific or site-specific goals for protecting human health and the environment that are established on the basis of the nature and extent of the contamination, the resources that are currently and potentially threatened, and the potential for human and environmental exposure. Remediation goals are site-specific, quantitative goals that define the extent of cleanup required to achieve the RAOs. These goals are PRGs in the FS, and they will be finalized in the ROD for the site.

Six RAOs were identified (four for soil and two for groundwater) to mitigate the potential present and/or future risks associated with the site. These RAOs were originally presented in the November 2003 Tech Memo (Exponent, 2003). Below is a summary of the RAOs developed for the site, with slight modifications based on April 23, 2004 NJDEP/USEPA comments on the Tech Memo.

2.2.1 RAOs for Soil

There is a potential for exposure to contaminated soil by receptors (adult workers/ excavation workers) that may present an unacceptable risk. An objective of this FS is to develop alternatives that will mitigate these risks to onsite receptors. In addition, contaminated soil at the site may impact groundwater, surface water, and sediment through potential migration. Consequently, an additional objective for remediation of the contaminated soil is to allow the goals for groundwater, surface water, and sediment remediation to be met.

The RAOs for soil at the site include:

- Prevent/minimize potential migration of contaminants in surface soil via windblown dust and surface runoff to the marsh area and Berry's Creek
- Prevent/minimize potential migration of contaminants to groundwater, which may discharge to surface water and sediment
- Prevent/minimize potential migration of contaminants in onsite sediments via surface runoff to the marsh area and Berry's Creek

- Reduce human and ecological receptors' potential exposure to contaminants in surface soil to within acceptable risk levels
- Reduce exposure to contaminants in soil in the undeveloped fill area to allow for reasonable anticipated future land use

Prevent/Minimize Potential Migration of Contaminants in Surface Soil via Windblown Dust and Surface Runoff to the Marsh Area and Berry's Creek. Possible erosion of surficial soil could result in the offsite migration of COCs at concentrations posing unacceptable risks through direct contact and ingestion within the undeveloped fill area, which is not covered with asphalt or concrete paving. Although this risk is minimal with the current vegetative covers over the undeveloped fill area, if future use dictates the need to remove the vegetation, erosion and transport could occur. This RAO is intended to prevent unacceptable risks to offsite receptors as a result of exposure to contaminated soil.

Prevent/Minimize Potential Migration of Contaminants to Groundwater, which may Discharge to Surface Water and Sediment. The COCs in groundwater have not been detected in groundwater at concentrations that exceed PRGs in monitoring wells adjacent to Berry's Creek (downgradient); thus, limited mass transfer has occurred. There is, however, the potential that without an additional remedial effort contaminant mass transfer from the solid phase to the liquid phase could occur. This RAO is intended to prevent unacceptable risk in surface water and sediment through desorption of contaminants from soil and subsequent migration of groundwater contamination.

Prevent/Minimize Potential Migration of Contaminants in Onsite Sediments via Surface Runoff to the Marsh Area and Berry's Creek. This RAO is related to the potential migration of impacted sediments within the drainage ditches that could result in offsite migration to Berry's Creek or the OU2 marsh areas. This RAO is intended to prevent unacceptable risks to offsite receptors as a result of migration of contaminated sediments.

Reduce Human and Ecological Receptors' Potential Exposure to Contaminants in Surface Soil to within Acceptable Risk Levels. Exposure to contaminated soil through direct contact and ingestion is not likely to occur on the site since the undeveloped fill area is currently unoccupied and fenced. The developed area of the site currently has existing engineering controls (building foundations and paved parking areas) that eliminate direct contact and/or ingestion. There is, however, a potential for redevelopment of the site, specifically within the undeveloped fill area, that may result in potential exposure to impacted soil if additional remedial efforts are not taken. This RAO is intended to prevent unacceptable risks to potential future industrial or excavation workers as a result of exposure to contaminated soil at the site.

Reduce Exposure to Contaminants in Soil in the Undeveloped Fill Area to Allow for Reasonable Anticipated Future Land Use. The current property owner of the undeveloped fill area is pursuing potential buyers to redevelop this area. Through the sales agreements, any potential buyer will agree to the applicable institutional controls necessary to restrict usage to nonresidential. This RAO is intended to propose remedial alternatives that are consistent with the proposed reuse of the area for light industrial development.

2.2.2 RAOs for Groundwater

The RAOs for groundwater at the site were developed to minimize further migration of the contaminant plume and limit impacts to the downgradient receptors (surface water and sediment in Berry's Creek).

The RAOs for remediation of groundwater at the site include the following:

- Prevent/minimize the potential downgradient and offsite migration of contaminated groundwater to the marsh area and Berry's Creek
- Reduce human and ecological receptors' potential exposure to contaminants in groundwater to within acceptable risk levels

Each of these RAOs is discussed in the following sections.

Prevent/Minimize the Potential Downgradient and Offsite Migration of Contaminated Groundwater to the Marsh Area and Berry's Creek. The COCs in groundwater have not been detected in groundwater at concentrations that exceed PRGs in monitoring wells adjacent to Berry's Creek (downgradient). There is, however, the potential that without an additional remedial effort, stormwater runoff and infiltration could cause migration of groundwater contaminants to surface water and sediment in the marsh area and/or Berry's Creek. This RAO is intended to prevent unacceptable risks in surface water and sediment through migration of groundwater contamination.

Reduce Human and Ecological Receptors' Potential Exposure to Contaminants in Groundwater to within Acceptable Risk Levels. This RAO is intended to prevent unacceptable risks to potential human and ecological receptors as a result of exposure to contaminated groundwater at the site.

2.3 Preliminary Remediation Goals

To meet the RAOs defined in Section 2.2, PRGs were developed to define the extent of contaminated media requiring remedial action. This section presents the PRGs and defines the volumes of affected media exceeding the PRGs that will be addressed in the FS process. In general, PRGs establish media-specific concentrations of COCs that will pose no unacceptable risk to human health and the environment. COCs are the list of chemicals that result in unacceptable risk based on the results of the risk assessment. The PRGs are developed taking the following into consideration:

- Chemical-specific ARARs and/or TBCs including applicable New Jersey Cleanup Criteria and federal MCLs
- PRGs representing concentration levels corresponding to an excess cancer risk between 1×10^{-4} and 1×10^{-6}, a chronic health risk defined by a Hazard Index (HI) of 1, and/or a significant ecological risk
- Factors related to technical limitations, uncertainties, and other pertinent information

Below is a summary of the PRGs for soil and groundwater established for OU1 at the site.

2.3.1 PRGs for Soil

Soil PRGs are presented in Table 2-1. The New Jersey Soil Cleanup Criteria (N.J.A.C. 7:7-1) for residential and nonresidential land use direct contact, and protection of groundwater soil cleanup criteria are included as the applicable PRGs for the site. The USEPA Region 9 PRGs [3], which cover the full risk range (1×10^{-4} and 1×10^{-6} excessive lifetime cancer risk [ELCR]) were also evaluated. Based on the evaluation, and as requested by NJDEP, NJDEP RDCSCC was chosen as the applicable soil PRGs within this FS.

2.3.2 PRGs for Groundwater

PRGs were developed for groundwater based on the RAOs discussed earlier. The NJDEP GWQC, USEPA federal MCLs, and USEPA Region 9 Tap Water PRGs[4] were compared to develop the groundwater PRGs. The PRGs for groundwater are listed in Table 2-2. New Jersey considers its GWQC to be the relevant PRGs for remediation of groundwater. Where New Jersey GWQC are lower than the federal MCLs, the GWQC are used as the PRG.

2.4 Contaminated Media Exceeding PRGs

The areas and depths of soil and groundwater that exceed the PRGs were developed comparing results with the applicable NJDEP cleanup criteria discussed above. Below is a discussion of the areas of soil and groundwater exceeding the PRGs for OU1.

2.4.1 Soil

Site data were evaluated for areas with concentrations exceeding the PRGs for mercury, arsenic, and lead (the soil COCs). The residential and non-residential criteria exceedances at the site are summarized in Appendix B. Mercury, the primary COC at the site, has been seen at concentrations over the PRG in the largest portion of OU1. Figures 2-1 and 2-2 depict the areas exceeding the RDCSCC (14 mg/kg) and NRDCSCC (270 mg/kg) for mercury in surface soil. Figures 2-3 and 2-4 depict the areas exceeding the RDCSCC and NRDCSCC for mercury in subsurface soil. Surface soil exceeding the RDCSCC PRG covers most of the developed area (including portions of Ethel Boulevard, the Blum property, the Prince Packing Property, and the EJB property) and a large portion of the undeveloped fill area. The highest concentration of mercury measured in surface soil during the RI was 13,800 mg/kg, in a sample collected from the vicinity of the former mercury processing plant, adjacent to the Wolf Warehouse (shown in Figure 2-1). Mercury concentrations in surface soil in the rest of the developed area above the RDCSCC ranged from 15.5 to 4,480 mg/kg. In addition, one hazardous substance (HS) sample collected from the undeveloped fill area (HS-5) yielded a mercury concentration of 295,000 mg/kg. This sample was characterized as white-yellow powdery material and melted thermometers. On the Blum and Prince Packing properties, the concentrations of mercury exceeded the RDCSCC, but were below the NRDCSCC (270 mg/kg). On the EJB property, only one location exceeded the NRDCSCC. The portion of the undeveloped fill area with concentrations exceeding the RDCSCC for mercury is also shown in Figure 2-1. Mercury concentrations in surface soil in the undeveloped fill area ranged from 1.2 to 583 mg/kg (see

3 Source: http://www.epa.gov/region09/waste/sfund/prg/index.htm

4 Source:http://www.epa.gov/region09/waste/sfund/prg/index.htm

Figure 2-1). The mercury exceedances of the NRDSCC are concentrated in small "pockets" in the center and the eastern portion of the undeveloped fill area (shown in Figure 2-2). The highest mercury concentration in surface soil in the undeveloped fill area was 583 mg/kg.

The subsurface area of mercury contamination (greater than 2 feet deep) is similar in size to the area in surface soil. The extent of subsurface contamination is depicted in Figure 2-3 (exceedances of the RDCSCC) and Figure 2-4 (exceedances of the NRDCSCC). As seen in Figure 2-3, the area exceeding the RDCSCC in subsurface soil covers approximately the same portion of the developed area as the surface soil, but does not extend as far north onto the Blum or Prince Packing properties. Subsurface mercury concentrations exceed the RDCSCC further south than in the surface soil in the undeveloped fill area, to the confluence of the Diamond Shamrock/Henkel (north) Ditch and Berry's Creek. Mercury concentrations in the subsurface soil at the site sampled during the RI range from 0.19 to 34,700 mg/kg. The second highest subsurface mercury soil concentration, 5,150 mg/kg, was, however, nearly an order of magnitude lower than the highest concentration (34,700 mg/kg). In the developed area, a portion of the property between the railroad right-of-way and the U.S. Life and Wolf Warehouses exceeded the NRDCSCC for mercury. In the undeveloped fill area, the NRDCSCC was exceeded in the eastern portion of the property, and in two small areas toward the western and southern boundaries. Based on these data, the overall mercury target area is defined by the combined areas of surface and subsurface soil exceedances of the RDCSCC extending to groundwater (assumed to be 4 feet bgs), taking into consideration tidal fluctuations. For cost estimating purposes, 4 feet bgs was assumed as the depth to mercury contamination in soil. This assumption is based on regional water level depth during the tidal cycle and mercury concentrations measured in soil during the RI (Exponent, 2004b). This assumption will be verified during field implementation.

Arsenic was also detected at concentrations exceeding the RDCSCC and NRDCSCC in surface and subsurface soil as shown in Figure 2-5. Note that the RDCSCC and NRDCSCC numbers for arsenic are the same (20 mg/kg). Arsenic concentrations exceeding the RDCSCC and NRDCSCC are all within the undeveloped fill area and were isolated to three distinct areas. The depths of arsenic contamination within each of the three areas varied, however. The highest concentration of arsenic (120 mg/kg) was found in a sample obtained from a test pit, just north of the Diamond Shamrock/Henkel (north) Ditch (Figure 2-5). The other locations where arsenic was detected exceeding the RDCSCC and NRDCSCC had concentrations that ranged from 21.1 mg/kg to 49.6 mg/kg. The isolated target areas for arsenic are much smaller than the mercury target area and are completely overlain by that target area.

The concentrations of lead over the RDCSCC and NRDCSCC are depicted in Figures 2-6 and 2-7, respectively. In surface soil, concentrations of lead in the undeveloped fill area ranged from 39.3 to 4,320 mg/kg. In addition, one HS sample collected from the undeveloped fill area (HS-6) yielded a lead concentration of 47,600 mg/kg. This sample was characterized as a hard, red pigment. Concentrations of lead found in subsurface soil during the RI ranged from 5.0 to 3,830 mg/kg. The extent of lead contamination exceeding the RDCSCC and NRDCSCC is primarily within the undeveloped fill area and extends over a large portion of the 19 acres. One location on the Lin-Mor property (SS-72) has a lead concentration of 410 ppm, which exceeds the RDCSCC. The area exceeding the NRDCSCC for lead is smaller and does not extend as far east as the concentrations exceeding the RDCSCC. The overall area of lead exceedances is completely within the target area for mercury.

2.4.2 Groundwater

The groundwater area exceeding PRGs is defined by the area over which concentrations of one or more COCs exceed the PRGs for groundwater. Figure 2-8 documents the areas exceeding the GWQC for mercury, arsenic, and benzene in groundwater. The area with exceedances of mercury, which is smaller than the overall target area, is also depicted in Figure 2-8. As seen in the figure, the overall target area for groundwater encompasses the area immediately surrounding the Wolf Warehouse (primarily mercury in these wells) and areas to the south-southeast toward Berry's Creek. The extent of mercury in groundwater over PRGs is localized in three wells surrounding the Wolf Warehouse. Based on boring logs prepared during Phase IA sampling, the estimated thickness of the surficial aquifer averages approximately 18 feet.

3 Identification and Screening of Technologies

3.1 General Response Actions

Identifying general response actions is the first step in the FS alternatives analysis process; the general response actions are basic actions that might be undertaken to remediate a site. For each general response action, several possible remedial technologies may exist. They can be further broken down into a number of process options. These technologies and process options are then screened based on several criteria. The general response actions for soil and groundwater are included in column one of Tables 3-1 and 3-2, respectively. The general response actions are then divided into individual technologies, as discussed in Section 3-2. Those technologies and process options remaining after screening are assembled into alternatives in Section 4 for OU1. After the RAOs and PRGs were developed, general response actions consistent with these objectives were identified. The following sections present general response actions that may be applicable to the site.

3.1.1 General Response Actions for Soil

The general response actions for soil at the site include:

- No action
- Monitoring
- Institutional controls
- Natural attenuation
- In situ treatment
- Containment
- Excavation/ex situ treatment/disposal

Each general response action for soil is discussed in the following paragraphs along with an overview of some of the technologies that are representative of the response action. The general response actions for soil are also listed in the first column of Table 3-1.

No Action. The no action response assumes no remedial action for soil except what may have been implemented in the past. The no action response would not satisfy the RAO of eliminating contact with the contaminated soil, preventing erosion, or eliminating potential migration to groundwater; therefore, this action is not feasible. The NCP requires that the no action alternative be retained through the FS process as a basis of comparison.

Monitoring. The monitoring response action includes periodic soil sampling and laboratory analysis to monitor the progress and/or effectiveness of remedial efforts. This response action alone does not satisfy RAOs, but may be used in conjunction with other response actions, or as part of a predesign investigation, to determine the long-term effectiveness of the implemented remedy, or as confirmatory sampling during any excavation actions.

Institutional Controls. Institutional controls for soil consist of restricting access to contaminated soil through options such as land use restrictions (i.e., Deed Notices). Institutional controls considered would be prepared in accordance with NJDEP requirements for Deed Notices and biennial monitoring (N.J.A.C. 7:26E-8.4 through 8-6). Deed Notices are the

NJDEP presumptive remedy for sites with contaminated historic fill material (N.J.A.C. 7:26E-6.2(c)).

Natural Attenuation. Natural attenuation is the reduction of contaminant concentrations through natural physical, chemical, or biological processes. These processes may include biodegradation, dilution, dispersion, retardation, and other processes. When natural attenuation is implemented as a remedy, monitoring is often required to document the decrease in contaminant concentrations.

In Situ Treatment. In situ treatment includes remedial actions that do not require the removal of contaminated media. Applicable in situ remedial technologies that can be used include physical/chemical, biological, and thermal processes. Some examples of in situ treatment that may be applicable at sites with metals contamination in soil include stabilization, soil flushing, and vitrification.

Containment. Containment response actions, such as caps, are used to prevent direct contact exposures. Asphalt, soil caps, concrete caps, and liner materials are applicable remedial technologies that can be used to eliminate exposure to contaminated soil. These actions will also limit the infiltration of precipitation and help prevent contaminant migration offsite. Surface controls such as grading and revegetating can also be used to reduce infiltration of precipitation through contaminated soil and prevent erosion and transport of contaminated soil.

Excavation/Treatment/Disposal. Excavation involves removal of impacted soil for disposal. The disposal can be completed either offsite or onsite. Offsite disposal can be completed at different types of landfills, dependent upon whether the material is hazardous or not.

Treatment would be required prior to disposal if the material is hazardous (characteristic – D009). Physical, chemical, or thermal treatment technologies are used as necessary to meet the treatment standards prior to disposal. Based on the knowledge of the concentration of contaminants present in the soil to be excavated at the site, there is the potential that all or part of the soil may be characteristically hazardous, which will require compliance with treatment standards before disposal.

Processes such as soil washing/flushing, thermal processes such as retorting, and stabilization can be implemented to treat the soil to comply with treatment standards were evaluated and are discussed below.

> ***Soil Washing.*** Soil washing is a water-based process for scrubbing soil ex situ to remove contaminants. The process removes contaminants from soil in one of two ways: (1) by dissolving or suspending them in the wash solution (which can be sustained by chemical manipulation of pH for a period of time) or (2) by concentrating them into a smaller volume of soil through particle size separation, gravity separation, and attrition scrubbing. The concept of reducing soil contamination through the use of particle size separation works because most organic and inorganic contaminants tend to bind, either chemically or physically, to clay, silt, and organic soil particles, which have very high specific surface areas. The silt and clay, in turn, are attached to sand and gravel particles by physical processes, primarily compaction and adhesion. Washing processes that separate the fine-grained clay and silt particles from the coarser sand and gravel soil particles effectively separate

and concentrate the contaminants into a smaller volume of soil that can be further treated or disposed of. Gravity separation is effective for removing high or low specific gravity particles such as heavy metal-containing compounds (lead, mercury, etc.). Attrition scrubbing removes adherent contaminant films from coarser particles.

Soil washing is most often applied to sites where less than 30 – 35 percent of the mass has a nominal particle size less than 0.063 mm. When the concentration of fines exceeds this range, conventional soil washing may have to include other treatments (e.g., flotation, density and gravity separation), washed material will have to be reprocessed, or several cycles of the same treatment (e.g., hydrocycloning) may have to be implemented. Although soil washing is sometimes used as a stand-alone treatment technology, more often it is combined with other technologies to complete site remediation.

The benefit of soil washing is that the amount of material requiring either mercury recovery or stabilization could be substantially less than other options, but this depends heavily on the percentage fines in the soil matrix. Conditions that favor soil washing include soil with a single principal contaminant metal that occurs in dense, insoluble particles that are adsorbed to a specific, small mass fraction(s) of the soil; a single contaminant metal species that is very water or aqueous leachate soluble and has a low soil/water partition coefficient; and soil containing a high proportion of coarse-grained soil particles. The disadvantages include secondary treatment of the concentrated waste volume and the generation of a wastewater volume that will require treatment prior to discharge. Soil with large amounts of fines and organics are less amenable to soil washing because of the strong chemical and physical attractions between smaller soil particles and contaminants. Proof of concept soil testing and, if retained for further evaluation, field pilot tests are typically recommended prior to full-scale implementation.

Retort. Retorting processes use heating and subsequent distillation techniques to extract mercury from impacted soil. There are three basic types of low temperature thermal desorption (LTTD) units: direct-fired, indirect-fired, and non-burn. In a direct-fired unit, the waste contacts the flame for efficient heat transfer. In an indirect-fired unit, the waste does not contact the flame, and the heat transfer rate through the separating shell is substantially slower than direct-fired systems. In the non-burn unit, the waste is contacted by flue gas containing low levels of oxygen that will not oxidize the contaminants. This design has better heat transfer characteristics than the indirect-fired system.

Thermal desorption units proposed for the retort of mercury-impacted soil typically employ an indirect heated rotary dryer with a condensation-style gas treatment system. Mercury-impacted soil would typically be heated to temperatures between 300°C and 600°C. The dryer is heated using natural gas, propane, or fuel oil. The heating is completely external to the soil-containing compartment, and the flue gases never contact the soil or mercury vapor. The products of combustion are discharged to the atmosphere as they would be from a conventional furnace. The desorbed mercury and water vapor are transported by steam generated in situ or by a carrier gas to the gas treatment system, where they are condensed. The water is separated, filtered (and treated if necessary) and then sprayed back into the treated soil to cool and wet it for dust control. The mercury is collected for offsite recycling. A small process vent stream is purged from the system to maintain the dryer at negative pressure.

Elemental mercury, with a boiling point of 357°C, volatilizes under normal low temperature thermal desorption conditions. Upon heating, mercurous and mercuric compounds may decompose into elemental mercury or volatilize and sublime. Mercuric chloride, for example sublimes with decomposition and boils at 303°C, mercuric oxide and mercuric sulfide decompose at 300 to 500°C to elemental mercury and oxygen and sulfur dioxide, respectively. The rates of these conversions affect the rate of volatilization of mercury derived from them and affect the required residence times for treating soil containing these types of species. Volatilization of water-soluble mercury compounds affects the amount of mercury in scrubber waters and the type of water treatment necessary. Mercury compounds in scrubbers can also cause emulsion problems. Certain waste characteristics cause difficulties in retorting processes, including organic forms of mercury, soil with high water content, mercury chloride, mercury nitrate/nitrite solutions, and wastes containing mercuric sulfides.

Stabilization. Stabilization processes are nondestructive methods to immobilize the hazardous constituents in a waste while decreasing the surface area and permeability. Common stabilization agents include Type 1 Portland cement, lime, fly ash, and organic binders such as asphalt. Ex situ stabilization can occur in continuous feed or batch systems. The final product can be a monolith of any practical size or a granular material resembling soil.

Mercury can be precipitated from aqueous solution by oxidation to the mercuric (+2) state and precipitation as mercuric sulfide using sodium sulfide, Na_2S, or sodium hydrogen sulfide, NaHS. Mercuric sulfide is very insoluble in water, making this compound a superior final waste form relative to other mercury compounds. The residual sulfide concentration needs to be closely controlled, however, to avoid mercury resolubilization as an anionic complex or as a colloidal dispersion of finely-divided mercury sulfide. Potassium sulfide and calcium polysulfides are also used to precipitate mercury salts from alkaline solution. Mercuric sulfide precipitation can be performed in a batch or continuous process. Thorough mixing is required to obtain a complete conversion of all dissolved mercury forms to the sulfide. Stabilization using cementitious materials has been used to treat mercury-bearing wastes. Kiln dust and fly ash are examples of pozzolanic materials. They tend to be high in oxides of silicon, aluminum, and/or iron. Other examples include certain volcanic rocks and industrial byproducts, such as granulated blast furnace slag and fume silica.

Typical stabilization processes involve dry mixing the impacted medium in a batch pug mill. Pilot testing determines the most suitable or effective stabilizing agent. Pug mill mixers are generally best suited for clean sand materials with little to no debris or large stones. Most dry stabilization processes usually have little to no secondary waste associated with them.

Several hazardous waste landfills in North America receive, stabilize, and dispose of characteristically hazardous, mercury-contaminated soil. These hazardous waste landfill facilities would likely accept the mercury-impacted soil from the project site for treatment prior to disposal. Several of these facilities have experience receiving and stabilizing characteristically hazardous, high-mercury waste. Analysis of prequalification samples is performed to determine whether the waste is acceptable for onsite processing and disposal. This analysis is done to determine whether the material can be processed and disposed of in the respective landfill.

3.1.2 General Response Actions for Groundwater

The general response actions evaluated for groundwater at the site include:

- No action
- Monitoring
- Institutional controls
- Natural Attenuation
- Containment
- In situ treatment
- Collection
- Ex situ treatment
- Discharge

Each general response action for groundwater is discussed in the following paragraphs along with an overview of some of the technologies that are representative of the response action. The groundwater general response actions are listed in column 1 of Table 3-2.

No Action. The no action response assumes no additional action for groundwater contamination. As with the no action response for soil, no action is retained through the FS process as a basis of comparison in accordance with the NCP. The no action response for groundwater would not meet the RAOs of preventing migration of COCs in groundwater or eliminating exposure pathways. It has been presumed that the no action response for groundwater will be coupled with the no action option for soil as a basis of comparison.

Monitoring. The monitoring response action includes periodic groundwater sampling and laboratory analysis through conventional sampling methods. This response action alone does not satisfy RAOs, but may be used in conjunction with other response actions or to determine the long-term effectiveness of the implemented remedy. Monitoring is usually required as part of institutional controls, as discussed below.

Institutional Controls. Institutional controls are restrictive covenants that eliminate potential future use of impacted groundwater. In New Jersey, the restrictive covenants are referred to as a Classification Exception Area (CEA). The CEA must include the area of impacted groundwater, the potential area of groundwater that may be impacted before completion of remedial actions, the contaminants and concentrations within the area, and an estimated duration of the CEA. Continued groundwater monitoring may also be necessary to track the direction and rate of movement of the groundwater contaminant plume as part of the institutional controls.

Natural Attenuation. Natural attenuation is the process by which contaminant concentrations are reduced by various naturally-occurring physical, chemical, and biological processes. The main processes include dilution, biodegradation, and retardation. Only unaugmented natural processes are relied upon under this general response action. Augmentation through the in situ addition of electron acceptors or nutrients is considered under in situ biological treatment technologies.

Containment. Containment is used to minimize the risk of contaminant migration through physical barriers to groundwater flow. Sheet pile walls and slurry walls are applicable remedial technologies that can be used to isolate an area of groundwater contamination. Surface controls such as capping can be used separately or in conjunction with groundwater containment to reduce infiltration to the contained area.

In Situ Treatment. In situ treatment of groundwater includes remedial actions that do not require the removal of the water before treatment. Remedial technologies that can be used in situ include physical/chemical, biological, and thermal processes. Some examples include chemical oxidation/reduction and passive/reactive treatment walls.

Collection. In this response action, groundwater is extracted from the aquifer using pumping wells. The rate of pumping and location of wells would depend on the purpose of the collection. If the groundwater is to be treated, the wells are often designed to "capture" the entire area of contaminated groundwater. Pumping rates may be lower if the groundwater is being collected to provide active hydraulic controls. Hydraulic controls prevent offsite migration of groundwater, but do not attempt to collect all the contaminated media for treatment.

Ex Situ Treatment. Before discharge of collected groundwater, contaminants would be removed from the water by physical, chemical, or biological treatment. Many process options are available to treat extracted groundwater, including precipitation, filtration, bioreactors, ion exchange, and media transfer (activated carbon). The treatment technology chosen depends on the flow rate, cost, and required effluent concentrations for discharge.

Discharge. The disposal of groundwater can be accomplished by subsurface injection (discharge to groundwater), discharge to surface water, or discharge to the publicly owned treatment works (POTW). Each option may have COC concentration limitations or permit requirements that must be met before discharge.

3.2 Technology Screening Methodology

In this section, the technology types and process options available for remediation of soil and groundwater are presented and screened. Screening begins with development of an inventory of technology types and process options based on professional experience, published sources, computer databases, and other available documentation for the general response actions identified in Section 3.1.

The evaluation and screening of technology types and process options are presented in Tables 3-1 and 3-2 for soil and groundwater, respectively. Each technology type and process option is either a demonstrated, proven process, or a potential process that has undergone laboratory trials or bench-scale testing. The initial screening of technology types and process options is presented in the first half of the tables based on technical implementability. The factors included in this evaluation are the following: the state of technology development, site conditions, waste characteristics, the nature and extent of contamination, and the presence of constituents that could limit the effectiveness of the technology. Entire technologies and individual process options are screened from further consideration based on technical implementability.

Process options that remain after the initial screening are further evaluated using a qualitative comparison based on effectiveness, implementability, and cost (presented in columns 6 through 8 of Tables 3-1 and 3-2). Following this qualitative screening, those remedial technology types and process options that are considered viable for remediating the media are carried forward for incorporation into alternatives. Those technology types and process options that are not technically implementable are shown in italicized and bolded text in the first half of the tables. Those that are not considered feasible based on effectiveness, implementability, and cost are shown in italicized and bolded text in the second half of the tables.

As mentioned above, technology types and process options are screened in an evaluation process based on effectiveness, implementability, and cost. Effectiveness is considered the ability of the process option to perform as part of a comprehensive remedial plan to meet RAOs under the conditions and limitations present. Additionally, the NCP defines effectiveness as the "degree to which an alternative reduces toxicity, mobility, or volume through treatment, minimizes residual risk, affords long-term protection, complies with ARARs, minimizes short-term impacts, and how quickly it achieves protection." This is a relative measure for comparison of process options that perform the same or similar functions. Implementability refers to the relative degree of difficulty anticipated in implementing a particular process option under regulatory, technical, and schedule constraints posed at a site. At this point, the cost criterion is comparative only, and similar to the effectiveness criterion, it is used to preclude further evaluation of process options that are very costly if there are other choices that perform similar functions with similar effectiveness. The cost criterion includes costs of construction and any long-term costs to operate and maintain technologies that are part of an alternative.

The NCP preference is for solutions that use treatment technologies to permanently reduce the toxicity, mobility, or volume of hazardous substances. Available treatment processes are typically divided into three technology types: physical/chemical, biological, and thermal, which are applied in one or more general response actions with varying results.

The technology types and process options identified in the following sections are those offering at least theoretical applicability to remediation of the media of concern at the site. This list of options should be considered dynamic, flexible, and subject to revision based on further investigation findings, results of treatability studies, or technological developments.

3.3 Technology Screening for Soil Media

Table 3-1 presents a wide range of potentially applicable technology types and process options for soil remediation at the site. Screening comments are provided to highlight items of interest or concern for each option. This approach highlights differences within a remedial technology group to allow the best process within each group to be identified and selected.

Potentially feasible technologies and process options for each general response action for remediation of soil at the site are shown in plain text (i.e., not italicized or bolded) in

Table 3-1. The response actions and associated technologies retained following screening include:

- No action
- Monitoring (soil sampling, predesign investigations, and/or air sampling)
- Institutional controls (land use restrictions)
- Containment using surface controls (grading and revegetation) and single layer caps (geomembrane liners, concrete, or asphalt pavement)
- Excavation
- Ex situ treatment (stabilization, soil washing, or retorting)
- Disposal offsite (hazardous or nonhazardous waste landfills)

The rationale for selecting these process options is presented in Table 3-1. The following sections highlight technologies where more detailed evaluation was necessary to distinguish between technologies or process options.

Monitoring. Soil sampling options, such as delineation sampling, air monitoring, and predesign investigations, were retained since they can be used in conjunction with various technologies to monitor the progress of other remedial actions or for characterization and/or final delineation sampling. Note that monitoring alone cannot be used as a stand-alone remedial technology, but is used in conjunction with other technologies.

Land Use Restrictions. Unless all soil target areas are treated to below PRGs or removed from the site, land use restrictions will be required. Since many of the soil remedial alternatives involve leaving some level of COCs exceeding PRGs, this technology was retained.

Containment. Under the containment response, surface controls such as grading and revegetation were retained because they are relatively inexpensive options and will effectively prevent direct contact exposure and erosion while reducing infiltration through contaminated soil. A single layer capping system (e.g., asphalt paving, compacted engineered soil fill) is also retained as a capping technology for the developed and undeveloped fill area because of potential future land use applications for the site, which is light industrial. In addition, existing asphalt in the developed area may meet or could be modified to meet RAOs without having to install a new cap in this area. Geomembrane liners and concrete caps were also retained as technologies that may be used in the adjacent West Ditch.

Excavation. Excavation was retained as a remedial technology to perform active mass removal of contaminated soil for treatment and disposal.

Ex Situ Treatment. Ex situ treatment was retained as a remedial technology since excavated soil may require treatment before disposal if they contain characteristically hazardous waste. Many of the ex situ treatment options were initially screened out because of the nature of contaminants in site soil. Based on the concentrations and probable types of mercury in the soil at the site, the ex situ treatment processes that are retained are ex situ stabilization, soil washing, and retorting.

Stabilization/solidification (S/S) was retained as the primary ex situ treatment technology. S/S technologies have been demonstrated for a wide variety of metals, including mercury and lead, at Superfund sites throughout the country. Mercury can be stabilized as mercuric sulfide using sodium sulfide, sodium hydrogen sulfide, or sodium/calcium polysulfides. Mercuric sulfide is very insoluble in water. S/S using cementitious materials, such as kiln dust and fly ash, have also been used to treat mercury-contaminated soil. Other examples of materials used for the S/S of mercury-contaminated soil include industrial byproducts, such as blast furnace slag and silica fume. S/S technologies are implementable and a variety of hazardous waste treat/dispose facilities and vendors have the capability and experience to treat mercury-contaminated soil.

Soil washing was retained as a secondary ex situ treatment technology. Soil with a high (i.e., greater than approximately 35 percent) silt and clay fraction clearly does not favor soil washing because of the strong chemical and physical attractions between the smaller soil particles and contaminants. Borings and test pits conducted during the RI show that fill layers at the site contaminated with high concentrations of mercury in the developed area consist of a wide variety of soil types, including sandy clay, fine to coarse gravel, and clay, all overlying silt. Soil that varies widely and frequently in significant characteristics such as soil type, contaminant type, and concentration are generally not amenable to soil washing because of the need to constantly adjust the operating parameters in the unit processes. Because of the heterogeneity of these mercury-impacted soil, the percent fines (i.e., sub-75-μm material) likely ranges anywhere from 30 percent to 70 percent. Furthermore, the soil in the undeveloped area contaminated with high concentrations of mercury has been described as fill consisting of wood, cinders, paper, glass, metal, building debris, and rubber, in addition to reddish brown fine-grained soil and some sand and gravel. The final limiting factor for the consideration of soil washing is the dewatering characteristics of the generated fines, which can dramatically limit treatment rates and add considerable disposal/treatment considerations.

Retorting was also retained as a secondary ex situ treatment technology. Offsite retorting facilities in the U.S. do not have the throughput capacity to process the potentially large volume of mercury-contaminated soil streams at the site. The majority of these facilities principally accept a single type of low-volume waste, such as fluorescent bulbs or mercury vapor lamps, and, for those facilities that accept mixed waste, the throughput processing is extremely limited because the systems were not designed to process large volumes of mercury-contaminated soil streams. A few U.S.-based companies do operate mobile thermal processing units that could be modified to handle mercury-impacted soil. Vendor experience is, however, very limited for sites where mercury is the primary COC, and the forms of mercury and carrier soil expected at the site may substantially limit treatment rates, especially because of the high water contents and potential high organic contents. Soil with high water content would cause a large quantity of generated steam to form, which would interfere with the mercury-condensation process. Solids treatment in a high-temperature furnace requires efficient heat transfer between the gas and solid phases, while minimizing particulates in the off-gas. The particle-size range that meets these objectives is limited. The presence of large clumps or debris (e.g., the large amount of brick and construction debris encountered at the site) slows heat transfer, so extensive pretreatment to either remove or pulverize oversize material would be required. Fine particles are also problematic because they become entrained in the gas flow, increasing the volume of dust to be removed from the flue gas. In addition, extensive air permitting and health and safety considerations would be required to avoid potential releases of vaporized mercury during the processing.

The volatilization of mercury compounds during retorting creates an extremely hazardous carrier gas stream that must be very carefully controlled and contained during the subsequent processing stages. Because of the site's close proximity to residential areas, from a health and safety perspective, onsite retorting operations may not be acceptable by the community.

Disposal. After removal, soil will be either: (1) managed and used as backfill onsite, or (2) disposed of offsite in an appropriately permitted landfill. For mercury-impacted soil that is not characteristically hazardous at the point of generation, the material may be sent for offsite disposal is at an appropriate landfill (nonhazardous or hazardous). For mercury-impacted soil that is characteristically hazardous, the material must be treated using the ex situ treatment option discussed above, and then disposed of at an appropriately permitted landfill and in compliance with applicable requirements.

3.4 Technology Screening for Groundwater Media

Using the same methodology described in the preceding section, Table 3-2 presents the results of a qualitative comparison of technology types and process options available for groundwater remediation at the site.

Potentially feasible technologies and process options for each general response action for remediation of groundwater at the site are shown in Table 3-2. The response actions and associated process options that were retained after screening for remediation of groundwater at the site include:

- No action
- Monitoring (groundwater sampling and/or predesign investigations)
- Institutional controls (CEA)
- Natural attenuation
- Containment (vertical hydraulic barrier)
- Collection of groundwater (extraction wells)
- Ex situ treatment
- Discharge (to POTW or surface water)

The rationale for selecting these process options is also presented in Table 3-2. The following sections highlight technologies where more detailed evaluation was necessary to distinguish between technologies or process options. These technologies include monitoring, natural attenuation, containment, collection, ex situ treatment, and groundwater discharge.

Monitoring. Groundwater sampling options were retained since they can be used in conjunction with various technologies to monitor the progress of other remedial actions, compliance sampling, and for monitoring natural attenuation. Groundwater monitoring is also usually required as part of the institutional controls. Note that monitoring alone cannot be used as a stand-alone remedial technology, but is used in conjunction with other technologies.

Natural Attenuation. Natural attenuation is the process by which contaminant concentrations are reduced by various naturally occurring physical, chemical, and biological processes.

Because of the nature of contaminants at the site, physical processes are expected to be the primary process in reducing constituent concentrations. These physical processes include dilution, dispersion, and transport; however, biological degradation of the volatile COC (benzene) may also reduce concentrations of this compound over time.

Containment. Containment refers to minimizing the spread of groundwater contaminants through active or passive hydraulic gradient controls. This process option protects downgradient receptors and minimizes or eliminates further migration of contaminated groundwater. Containment options also prevent clean groundwater from passing through the impacted media and, hence, prevent additional contamination of the resource. Passive gradient controls such as vertical hydraulic barriers (e.g., slurry walls and sealed sheet pile walls) were considered. Sealed sheet pile walls were retained because installation is straightforward and efficient, especially in areas with limited working area or where site operations are not easily shut down (e.g., in the vicinity of active warehouse operations). The slurry wall process option was also retained because the installation process is more flexible in the event subsurface debris is encountered, and slurry walls are a proven technology at a large number of hazardous waste sites. Active gradient controls can be accomplished with pumping wells at the site, and are described further as part of the "collection" technology.

Collection. Groundwater is extracted from the shallow aquifer using pumping wells. The contaminants are then treated ex situ (as discussed in the following paragraphs) for ultimate disposal, as required according to the requirements of the chosen discharge option. Initially, active pump and treat operations can be highly effective; however, this process option becomes much less effective with time, thus making it a more costly process option. Pump and treat operations involve the collection of larger volumes of groundwater than other alternatives involving groundwater extraction, such as active hydraulic controls. Active hydraulic controls require the pumping of lower volumes of water, not for the purpose of collecting and treating contaminated water, but to prevent offsite migration of groundwater by capturing the downgradient edge of the plume as it naturally migrates through the area.

Ex Situ Treatment. Because of the COCs (mainly mercury), the salinity of the water, and the low discharge requirements necessary for meeting either discharge to surface water or a discharge to the POTW, only three ex situ treatment options were found to be potentially viable. These technologies are filtration (for solids, iron, and manganese removal, as needed), granular activated carbon (GAC), and ion exchange. Other technologies, such as nanofiltration, reverse osmosis, and precipitation, are viable for mercury treatment, and were retained; however, since they are either more innovative (such as nanofiltration) or much more costly than GAC or ion exchange, it is anticipated that these technologies will be less effective than GAC or ion exchange.

Groundwater Discharge. Several discharge options are available for treated groundwater, such as injection of treated groundwater back into the unconfined aquifer, discharge to the POTW, and discharge to surface water. After review of the concentrations of compounds in groundwater (specifically mercury), the hydrogeologic conditions at the site, and the discharge requirements necessary, reinjection was determined to not be appropriate for the site, because of the high water table. Mounding concerns and nearby surface water also make this option undesirable for the site.

Discharge to the POTW may be an option, but may require connection and discharge fees for the life of the remedial action. Additional monitoring requirements (such as total solids, lower explosive limits [LEL], biological oxygen demand [BOD], and chemical oxygen demand [COD], limitations of permits) may also dictate discharge to the POTW. The POTW, through an application-to-discharge process, would have to approve the acceptance of any discharge. To date, no application to discharge has been submitted to the local POTW.

Discharge to surface water is also likely limited by specific discharge permit requirements that must be met.

4 Development of Alternatives

The remedial technologies and process options that remained after screening for soil and groundwater media at the site were assembled into a range of alternatives for OU1. The remedial alternatives have been developed separately for contaminated soil and groundwater media to allow for a wider range of alternatives and greater flexibility in selecting the recommended alternatives. There are, however, usually situations where alternatives for soil and groundwater are coupled for a higher degree of effectiveness, which is believed to be the case at the site. Details on how remedial alternatives will be coupled to increase effectiveness and achieve RAOs are discussed in further detail in Section 5.

The specific details of the remedial components discussed for each alternative are intended to serve as representative examples to generate cost estimates within +50 to -30 percent of the actual cost. Other viable process options within the same remedial technology that achieve the same objectives may be evaluated during remedial design activities for the site. The volumes of impacted media, technology process options, and all assumptions presented in this section were prepared based on current data and were assumed, for cost estimating purposes only. These assumptions may change after data collection during remedial design and/or during predesign investigation activities.

4.1 Development of Soil Media Remedial Alternatives

Seven soil media alternatives were developed to create a range of remedial actions, and include all the remaining technologies into at least one alternative. Table 4-1 presents a matrix of technologies that remained after initial screening and the alternatives into which they were incorporated. Table 4-2 includes a summary of the remedial technologies that will be used at each property within the OU1 FS boundary. The remedial action objectives for soil are as follows:

- Prevent/minimize potential migration of contaminants in surface soil via windblown dust and surface runoff to the marsh area and Berry's Creek
- Prevent/minimize potential migration of contaminants to ground water, which may discharge to surface water and sediment
- Prevent/minimize potential migration of contaminants in onsite sediments via surface runoff to the marsh area and Berry's Creek
- Reduce human and ecological receptors' potential exposure to contaminants in surface soil to within acceptable risk levels
- Reduce exposure to contaminants in soil in the undeveloped fill area to allow for reasonable anticipated future land use

Below is a summary of each of the soil media alternatives.

Soil Media Alternative 1—No Further Action. The objective of Soil Media Alternative 1 (S1), the No Further Action Alternative, is to provide a baseline for evaluation of remedial alternatives, as required by the NCP. Under this alternative, there would be no additional remedial actions conducted at the site to control or remove the COCs in soil. There would be a risk from direct contact with mercury if the site were to be developed in the future for industrial use if no further action were taken; also, downgradient receptors may be impacted through migration (such as surface runoff or leaching of COCs) if no action is taken.

Soil Media Alternative 2—Use Restrictions for Properties with Deed Notice Concurrence and Limited Excavation to RDCSCC. The objective of Soil Media Alternative 2 (S2) is to meet the RAOs by: (1) excavating soil within the 55-foot buffer area adjacent to the Diamond Shamrock/Henkel (north) Ditch for placement in the undeveloped area, (2) excavating and placement of excavated materials under the cap in the undeveloped area and then capping the west ditch with a geomembrane liner and clean fill material, (3) placing a cap over the undeveloped fill area and EJB property, (4) using existing caps in the developed area (with upgrades), and (5) excavating on the Lin-Mor property for placement under the cap in the undeveloped area. Figure 4-1 presents the conceptual layout of the locations of each cap proposed under this alternative. In the developed area, the U.S. Life and Wolf Warehouse foundations and parking areas, Borough of Wood-Ridge property (Ethel Boulevard), and the railroad gravel sub-base will be the applicable caps (with upgrades). Newly installed caps will be the engineering controls in the undeveloped fill area and the EJB property. Excavation on the Lin-Mor property to RDCSCC levels for COCs will occur with placement of the excavated material under the cap in the undeveloped fill area. Land use restrictions will apply to properties with levels of COCs above RDCSCC. Biennial, mercury-specific, indoor air monitoring of the Wolf Warehouse will be implemented through the 5-year Review period. As part of this alternative, removal of the drain line (if it still exists) in the undeveloped fill area is also included before the installation of the cap to eliminate any potential future migration of COCs to Berry's Creek.

The soil remedial objectives are met by Soil Alternative S2 through the prevention of direct contact to impacted soil, preventing continued erosion of contaminated soil, eliminating potential migration through surface water runoff, and minimizing leaching to groundwater. The main components of this alternative are:

- Land use restrictions
- Air monitoring
- Grading
- Asphalt and building foundation caps (existing)
- Single layer cap
- Excavation (soil on Lin-Mor property)
- Excavation (drain line removal)
- Excavation (55-foot buffer)
- Capping of the West Ditch
- Soil reuse (55-foot buffer and Lin-Mor soil)
- Offsite disposal

Details of these components for Soil Alternative S2 are discussed below.

Land Use Restrictions. Institutional controls (Deed Notices) consist of land use restrictions for all areas with exceedances of the RDCSCC. The Deed Notices for each impacted property will be prepared in accordance with the NJDEP *Technical Requirements for Site Remediation* N.J.A.C. 7:26E, specifically Section 8.2, Appendix E, and will include a summary of the engineering controls for each property, the locations of the engineering controls, specification on the controls, and monitoring and maintenance requirements. As part of the land restriction, biennial certifications will also be submitted while the engineering and institutional controls remain in place. The biennial certifications include inspections of the site to verify the integrity of the engineering controls, determine if any disturbances have occurred to the controls, and verify the engineering controls are still protective of human health and the environment. Deed notices will be prepared for properties with remaining levels of Site COCs above the RDCSCC (Blum, Prince Packing, Wolf Warehouse, U.S. Life Warehouse, EJB, Borough of Wood-Ridge, Norfolk Southern, and the undeveloped fill area). Appendix E includes copies of letters from property owners stating their willingness to consider the recording of deed notices for their properties impacted by the Site's contamination.

Air Monitoring. Indoor air samples for mercury will be collected in the Wolf Warehouse during the summer and winter seasons for the first year, and then biennially thereafter. While the potential for particulate mercury concentrations indoors is unlikely, the proposed sampling method will be able to trap and analyze both particulate and vapor phase mercury concentrations. The mercury analytical results in air will be compared with residential RBC values – 0.31 $\mu g/m^3$ for mercury vapor and 1.1 $\mu g/m^3$ for particle-phase mercury. The results from biennial sampling will be reevaluated at the time of the five year review. For costing purposes in this FS, it is assumed that biennial monitoring for gaseous and particulate mercury will be required for 30 years.

Grading. The current elevation of the site is generally flat; however, limited grading will be required (specifically in the undeveloped fill area) before installation of the cap to ensure surface drainage does not damage the wetlands adjacent to Berry's Creek and that runoff is controlled and routed properly. Note that, because of the extensive clearing and grubbing that will be required for the undeveloped fill area, regrading will also be necessary because of the uneven terrain after uprooting large trees. It is anticipated that grading will either be completed using site materials or through paving thickness differences to maintain adequate slopes to allow for proper drainage.

Asphalt and Building Foundation Caps (Existing). The current caps in the developed areas of the site will remain in place as the engineering controls and will be upgraded, as necessary, to promote proper drainage. The cap for the developed area includes: (1) the building foundations of the U.S. Life Warehouse and the Wolf Warehouse, (2) the asphalt caps used for parking and/or streets adjacent to the buildings, (3) the existing street of Ethel Boulevard, and (4) the existing gravel sub-base of the Norfolk Southern railroad property. The conceptual locations of the existing caps that will be used in the developed area are illustrated in Figure 4-1. The objective of these caps is to prevent direct contact and erosion of impacted soil, and to minimize infiltration in the areas where leaching is of greatest concern (i.e., where the highest concentrations of mercury have been detected near the Wolf Warehouse). The current floors of the Wolf and U.S. Life Warehouses will serve as the cap over the encapsulated mercury area, which lies beneath the Wolf Warehouse. Upgrades to the asphalt caps will include resurfacing to repair any existing cracks or breaches in the surface and surface water reconfiguration, such that the volume and velocity of overland flow is reduced and ponding of water is minimized. Within the area between the U.S. Life and Wolf Warehouses where water currently ponds, a detailed evaluation of the tidal floodplain and surface water drainage patterns will be completed to ensure water will not encroach upon the caps. It is anticipated that the elevation will be raised so it will no longer be a low point, and will drain surface water toward the ditch along the southern side of the warehouses. Along the southern perimeter of the developed area, the asphalt will be bermed to ensure surface water runoff is directed properly away from the ditch south of the warehouses (West Ditch). It is anticipated that most of the surface water runoff over the developed area will be directed toward the undeveloped fill area for collection by the surface water runoff system discussed below. Assumptions associated with the anticipated cap and berm descriptions and locations described above were made for cost estimating purposes only, and may change during the design phase of this project.

As mentioned above, it has been assumed that, for cost estimating purposes, the integrity of the caps within the developed area will be monitored every 2 years to ensure there are no breaches open for human direct contact exposure pathways. The results of the inspections will be reported within biennial reports, as required under the Deed Notices.

Single Layer Cap. A single layer cap will be placed over the target area within the undeveloped fill area, and over the small property between Ethel Boulevard and the railroad (the EJB property), as designated in Figure 4-1. For cost estimating purposes, this single layer cap has been assumed to include an asphalt cap over a gravel sub-base for stability. The cap has been assumed to consist of a 4-inch-thick asphalt cover (2 inches of wear course and 2 inches of top coat) over a 6-inch gravel sub-base. The general cross section of the asphalt cap used in costing this alternative is included in Figure 4-2. Note that this is the general design of the single layer cap in the undeveloped fill area and, as with all descriptions for this alternative that follow, assumptions were made for cost estimating purposes. Specific details for the cap will be determined during remedial design. If redevelopment of this area is to occur, the final cap may differ (e.g., thicker sub-base with the potential of additional stabilization for buildings and/or heavy equipment, such as piling, or the use of new building foundations as the engineering control). This cap will prevent direct contact with impacted soil in the undeveloped fill area, and also minimize potential migration of contamination by controlling surface water runoff. The entire area will be sloped to ensure surface water drainage will be away from the center of the undeveloped fill area. Along the perimeter of the paved area, berms (assumed at 12 to 16 inches high and 12 inches wide for cost estimating purposes) will be constructed to capture surface water flow and direct it to three discharge points (designated as stormwater control devices) along Berry's Creek. The exact design of the berms will be determined during detailed design activities and take into account 50- and 100-year rainfall events in the vicinity of the site. The exact locations of the discharge points will be determined during remedial design of the cap and will take into consideration the 100-year floodplain and applicable discharge requirements to Berry's Creek. The stormwater control devices will consist of a 3-foot by 3-foot box culvert for water collection, with rip-rap stone placed at the effluent of the culvert box to eliminate potential erosion at the discharge points.

During the removal of existing vegetation in the undeveloped fill area, temporary erosion controls will be set into place to ensure no soil erosion occurs before the cap installation. As with the existing cap discussed above for the developed area, the integrity of this newly installed cap will be monitored every 2 years to ensure there are no breaches that may be human exposure routes or cause surface water infiltration. The results of the inspections will be reported within biennial reports, as required under the Deed Notices.

Because of setbacks from wetlands, development cannot be completed within 50 feet of a wetland in both the Wood-Ridge and Carlstadt districts. Based on the wetlands delineation report (Shisler, 1997), wetlands are present at the eastern portion of the site along Berry's Creek, the Diamond Shamrock/Henkel (north) Ditch located south of the undeveloped fill area of the site, and the West Ditch. Capping was, therefore, not proposed in these areas, but the specifics of the remedy for these areas are addressed below.

Excavation (Soil on Lin-Mor Property). The impacted target areas of the Lin-Mor property will be removed and placed in the undeveloped fill area to be capped, as discussed above. The excavation of COC-impacted soil in this area will be completed using standard equipment (backhoes, front-end loaders, etc.) to an approximate depth of 2 feet, and as necessary to meet the RDCSCC of the site COCs (14 mg/kg for Hg, 400 mg/kg for Pb, and 20 mg/kg for As). The soil from this area (assumed to be approximately 700 cubic yards) will be placed and compacted in the undeveloped fill area before installation of the cap. Excavation to the RDCSCC values will allow for unrestricted use of this property in the future.

Excavation (Drain Line Removal). According to historical information, a buried drain line was located in the northeastern portion of the site, generally running from the developed area to Berry's Creek. During past investigation activities, this drain line could not be located; however, if it still exists, there is a chance this line could continue to provide a migration pathway from the developed area to Berry's Creek, even after the installation of the cap in the undeveloped fill area. Attempts will, therefore, be made to locate and remove this drain line as part of this alternative. The drain line will be initially located with historical maps and trenching perpendicular to the drain line by using standard equipment (backhoes, front-end loaders, etc.). After locating the line, the length of the line will be removed. Soil handled during the removal of the drain line will be sampled and disposed of in accordance with applicable treatment and disposal requirements. For cost estimating purposes, it has been assumed that this soil will be placed within the undeveloped fill area for capping, since the results of soil samples in the northern portion of the undeveloped fill area are generally lower than those concentrations in other areas (such as adjacent to the Wolf Warehouse).

Excavation (55-Foot Buffer). Soil within a 55-foot buffer adjacent to Berry's Creek, the Diamond Shamrock/Henkel (north) Ditch, and the West Ditch will be excavated and placed under the undeveloped fill area cap. An estimated 22,550 cubic yards of material (assuming a 4-foot excavation depth) will be removed from the 55-foot buffer area and placed within the proposed cap area in the undeveloped fill area. A 55-foot buffer was chosen such that the cap covers a 5-foot portion of the clean buffer to reduce the potential for exposure of contaminants to animals that may burrow under the edge of the cap. Sampling will be performed on the soil when generated to determine if it can be placed on the undeveloped fill area for capping. If mercury concentrations exceed 620 mg/kg (which is one order of magnitude over the USEPA Region 9 PRG for industrial use as discussed further in Soil Alternatives S3 through S7), the soil will be treated, if necessary, (as discussed in Soil Alternatives S3 through S7 below) and disposed of offsite rather than reused. It has been assumed that, for cost estimating purposes, the soil generated from the 55-foot buffer will be placed in the undeveloped fill area for capping and will not require treatment or offsite disposal. Certified clean fill material will be placed in the excavated 55-foot buffer and native vegetation and erosion controls will be installed to stabilize the fill and minimize erosion.

Capping of the West Ditch. In order to promote proper drainage of the site surface water, and to ensure that the proposed caps do not collect standing water during high tides and/or heavy rain events, the West Ditch will be regraded, capped, and rehabilitated. The Diamond Shamrock/Henkel (north) Ditch will be considered in the remedial action and design efforts of OU2.

The West Ditch will be regraded to create a base slope to promote drainage from an elevation high (approximately 3 feet msl) near the northern terminus of the ditch near the railroad track behind the Wolf Warehouse to its outlet to the Diamond Shamrock/Henkel (north) Ditch (approximately 1 feet msl). First, approximately 0.5 to 2 feet of soil will be excavated from the ditch to below the benthic layer to rehabilitate and lower the grade of the bottom of the ditch. Then, a geomembrane liner material (assumed as a 30-mil liner, for cost estimating purposes, but will be confirmed during predesign studies) will be placed over the ditch channel. It is anticipated the liner will be a 20-foot-wide roll of material that will be keyed into the clean fill material in the 55-foot buffer for stabilization. After placement of the geomembrane liner, a minimum of 1 foot of certified clean fill material will be placed over the geomembrane and revegetated to stabilize the soil and re-establish benthic habitat. If necessary, existing root mass within the ditch will be removed to ensure the geomembrane is not disturbed over time.

Assuming an average excavation of the ditch of 1 foot, removal of an estimated 450 cubic yards of soil will occur. Based on the concentrations of mercury in this soil, it has been assumed, for cost estimating purposes, that the soil will be nonhazardous and can be disposed of at a nonhazardous landfill. Specific details regarding the excavation depth, liner design and installation, and soil management will be determined during the design phase of the project. Costs for wetlands mitigation along the West Ditch are also included in the cost estimates. Mitigation will be required in this area because of the disturbance of the wetlands.

The design of the existing cap upgrades, the new cap in the undeveloped fill area, and the capping of the West Ditch will also take into account the current flooding of the developed area, the tidal actions within the ditch, and the 100-year floodplain surrounding the site to ensure water will not encroach the caps during high tide or scour the stream channel after restoration. As part of the remedial design of the ditch, therefore, the floodplain within the area of the site will be studied. Two aspects about the floodplain that will be studied include: (1) loss of storage through tidal influence redirection, and (2) loss of conveyance.

The storage of floodwaters within the 100-year floodplain can often be compensated by excavating a similar amount of volume otherwise cut off from the floodplain when the site is raised or isolated by dikes. The volume would be equivalent to the average depth of the 100-year flood level times the isolated area (e.g., cubic feet or acre-ft). Enlarging the drainage ditches or excavating a similar volume of soil from elsewhere in the floodplain may offset the loss of storage. Removing the standing water under normal or seasonal high tidal conditions is the minimum amount of floodplain mitigation expected for the developed area, and protecting the site from the entire 100-year flood will require more effort. To remove only the normal tidal inundation, it has been assumed that, for cost estimating purposes, the southern portion of the developed area (adjacent to the rail spur south of the warehouses) will be raised by several feet to minimize tidal propagation in this area. During the design phase, engineering controls (e.g., installation of a tide gate or other vertical hydraulic barrier between the northern end of the West Ditch and the warehouse areas) will be considered. It is possible that the modifications to the developed area may have a negligible impact, since the drainage basin contains significant storage in nearby wetlands, but this will be demonstrated in a floodplain analysis during remedial design.

Soil Reuse (55-Foot Buffer and Lin-Mor Soil). As mentioned above, soil excavated within the 55-foot buffer and from the Lin-Mor property will be placed in the undeveloped fill area for capping. Soil sampling will be completed on this soil before placement to ensure it can be reused at the site.

Offsite Disposal. Soil generated from the West Ditch excavation will be disposed of at a nonhazardous waste landfill. It has been assumed that, for cost estimating purposes, no additional treatment is necessary for this soil and that the soil will not be characteristically hazardous after sampling.

Cost Estimate Assumptions

The following are the assumptions used for cost estimating purposes as part of the FS, and may be changed during the design phase of the project:

- Eight Deed Notices will be prepared (assumed one each for the Blum property, the Prince Packing property, the EJB property, the Norfolk Southern property, the U.S. Life Warehouse, the Wolf Warehouse, the Borough of Wood-Ridge, and the undeveloped fill area).
- Air monitoring will consist of 3 stations, 2 samples per station, 2 field duplicates, and 1 field blank, for a total of 9 samples per event.
- The single layer cap in the undeveloped fill area will be a 4-inch-thick paved surface (assumed to be 2 inches of wear course and 2 inches of top coat). The sub-base material will be 6 inches thick.
- The existing paved areas and foundations in the developed area will provide an adequate engineering control, with applicable upgrades.
- Approximately 10 percent of additional top coat will be needed to re-grade the developed area to promote surface water drainage.
- All soil in the area of the drain line removal will be placed back into the trench and capped unless sample analysis dictates the need for treatment and/or offsite disposal.

For cost estimating purposes, it has been assumed soil generated during the drain line removal will be placed in the area to be capped in the undeveloped fill area.

- Soil within the 55-foot buffer will be excavated to an average depth of 4 feet and placed below the undeveloped fill area cap. Certified clean fill material will be used to replace the excavated material within the 55-foot buffer.
- Approximately 1 foot of soil will be excavated from the West Ditch. Certified clean fill material will be placed above a geomembrane liner and revegetated to promote restoration of habitat.
- It has been assumed that approximately 450 cubic yards of soil will be generated during rehabilitation of the West Ditch and will be transported for offsite disposal at a nonhazardous waste landfill.
- A sampling allowance, based on cubic yards of excavated material, has been included to account for sampling activities and analytical costs related to conformance sampling. Specific sampling requirements developed during the work planning and predesign phases of the project will include pre-excavation and post-excavation confirmatory sampling as necessary based on agency review. Samples will be collected in accordance with NJDEP sampling procedures, and soil samples will be analyzed by a New-Jersey-certified laboratory.
- No additional long-term surface water containment or erosion controls will be necessary for the undeveloped fill area after completion of the cap.
- No clean fill material will be required for grading of the undeveloped fill area.
- One percent of the cap areas will need to be repaired on an annual basis (both the existing and new cap).
- Approximately 30 percent of the cap areas will need to be repaired at year 30.

Soil Media Alternative 3—Excavation of Undeveloped Area with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC. The objective of Soil Media Alternative 3 (S3) is to meet the RAOs by (1) the excavation of soil with concentrations of mercury over 620 mg/kg in the undeveloped fill area, (2) excavation of soil within the 55-foot buffer area for placement in the undeveloped fill area, (3) lining of the West Ditch, (4) placing a cap over the undeveloped fill area (after excavation) and on the EJB property, (5) using the existing caps (with upgrades) for the developed area, and (6) excavation on the Lin-Mor property for placement under the cap in the undeveloped fill area. Biennial, mercury-specific, indoor air monitoring of the Wolf Warehouse will be implemented through the 5-year Review period. Figure 4-3 presents the location of the proposed excavation and the areas that will be capped under this alternative. As with Soil Alternative S2, the drain line within the undeveloped fill area will be located and removed before the installation of the cap.

The soil remedial objectives are met by Soil Alternative S3 through prevention of direct contact to impacted soil, preventing continued erosion of contaminated soil, eliminating potential migration through surface water runoff, and minimizing leaching to groundwater. The main components of this alternative are:

- Land use restrictions
- Air monitoring
- Grading
- Asphalt and building foundation caps (existing)
- Single layer cap (new)
- Excavation (drain line removal)
- Excavation (soil from Lin-Mor and Undeveloped Fill Area)
- Excavation (55-foot buffer)
- Capping of the West Ditch
- Treatment (soil characteristically hazardous for mercury)
- Soil reuse (55-foot buffer and Lin-Mor soil)
- Offsite disposal

The components of Soil Alternative S3 are discussed below.

Land Use Restrictions. The land use restrictions will be implemented as described in Soil Alternative S2. If a notice of intent for a deed notice(s) from an adjacent property(ies) is not obtained prior to remedial construction, that property(ies) will be excavated to the RDCSCC for the site's COCs.

Air Monitoring. Biennial air monitoring in the Wolf Warehouse will be conducted as described in Soil Alternative S2.

Grading. Grading, as necessary to promote cap installation and drainage in the undeveloped fill area, will be implemented as described in Soil Alternative S2. It is anticipated that the same equipment used to remove the drain line in the undeveloped fill area will also be used for grading.

Asphalt Cap (Existing). The asphalt and building foundations caps for the developed area (the U.S. Life and Wolf Warehouses, the paved parking areas, Borough of Wood-Ridge roadways, and the railroad) will be upgraded and maintained as described in Soil Alternative S2.

Single Layer Cap. The cap for the undeveloped fill area and the EJB property will be implemented as described in Soil Alternative S2. This cap will be installed after the drain line removal, placement of excavated soil from the Lin-Mor property and the 55-foot buffer, and excavation of soil with mercury concentrations exceeding 620 mg/kg (discussed below). The excavation area will also be capped after it is backfilled with clean material.

Excavation (Drain Line Removal). The drain line removal will be implemented as described in Soil Alternative S2. This activity will be completed concurrent with the excavation of soil discussed below.

Excavation (Soil from Lin-Mor and Undeveloped Fill Area). Soil within the undeveloped fill area with mercury concentrations exceeding 620 mg/kg will be excavated, treated as required, and disposed of at an offsite landfill. Treatment and disposal at a hazardous waste landfill was considered for cost estimating purposes. The areas exceeding 620 mg/kg for mercury were chosen as the target areas since these concentrations are an order of magnitude over the USEPA Region 9 PRG for 1×10^{-6} risk for industrial use (62 mg/kg).

The areas where soil will be excavated are illustrated in Figure 4-3. The volume of mercury-impacted subsurface soil requiring excavation within the undeveloped fill area is estimated at approximately 2,100 cubic yards, assuming an average excavation depth of 4 feet, and will be completed using standard equipment (backhoes, front-end loaders, etc.).

For cost estimating purposes, it has been assumed that the entire excavation will be to a depth of 4 feet; however, the depth may change during the design phase. Additionally, it is assumed that no benching and/or shoring will be required at the 4-foot excavation depth; however, these details will be further evaluated during the remedial design and/or predesign testing. The impacted target areas on the Lin-Mor property will also be removed and placed in the undeveloped fill area to be capped as discussed in Soil Alternative S2.

Before the start of any excavation, clearing and grubbing will be required. Based on the depths of the excavation, it is not anticipated that geotechnical stabilization of the excavation footprint will be necessary. The excavation will be sloped (assumed to be a 2:1 sloping), if necessary, during the excavation.

The excavation areas will be backfilled with certified clean fill material. The backfill will be similar in properties (porosity, grain size) as the native material. The backfilled material will be compacted and will be finished flush with the existing ground surface to promote capping. It has been assumed that an additional 20 percent of clean fill will be needed to compact the excavation footprint to grade.

Temporary stormwater diversion and soil erosion and sediment control measures will be established before any excavation begins. As necessary, staging areas will be created to allow for temporary stockpiling of soil during excavation, before loading. The areas will be bermed and lined in accordance with the stormwater control measures.

Excavation (55-Foot Buffer). Soil within the 55-foot buffer will be excavated and placed under the undeveloped fill area cap, as discussed in Soil Alternative S2. Certified clean fill material be placed in the excavated 55-foot buffer, and native vegetation and erosion controls will be installed to stabilize the fill and minimize erosion. As with Soil Alternative S2, it has been assumed that, for cost estimating purposes, soil generated within the 55-foot buffer will not require treatment before placement in the undeveloped fill area, and will not have concentrations of mercury exceeding 620 mg/kg or characterized as hazardous. If mercury concentrations are found to be above 620 mg/kg, or are designated as hazardous, the soil will be treated as required and disposed of offsite, as described in Alternative S2 above.

Capping of the West Ditch. Capping of the West Ditch will be completed using a geomembrane liner material as discussed in Soil Alternative S2. The details of the floodplain evaluation, as discussed in Soil Alternative S2, will also be completed on the West Ditch to determine any required changes to the floodplain to manage tidal surface water flow.

Treatment (Soil Characteristically Hazardous for Mercury). Soil generated during the excavation in the undeveloped fill area (assumed quantity of 2,100 cubic yards) with mercury exceeding 620 mg/kg will be treated, if necessary, and disposed of at an offsite landfill. Offsite stabilization and offsite disposal of the treated soil were assumed for cost estimating purposes. A treatability study will be completed during the design phase to assess the effectiveness of stabilization. If stabilization of mercury-impacted soil to treatment standards is not practical, other treatment options will be explored, including retorting and soil washing.

Soil Reuse (55-Foot Buffer and Lin-Mor Soil). As with Soil Alternative S2, soil excavated within the 55-foot buffer and from the Lin-Mor property will be placed in the undeveloped fill area prior to capping. Soil sampling will be completed on this soil before placement to ensure it can be reused at the site.

Offsite Disposal. Soil generated from the West Ditch will be disposed of at a nonhazardous waste landfill. It has been assumed, for costing purposes, that no additional treatment is necessary for this soil, and that the soil will not be characteristically hazardous after sampling.

Cost Estimate Assumptions

The following are the assumptions used for cost estimating purposes as part of the FS, and may be changed during predesign studies or the remedial design:

- Eight Deed Notices will be prepared (assumed one each for the EJB property, the Norfolk Southern property, the U.S. Life Warehouse, the Wolf Warehouse, the Blum property, and the Prince Packing property, the Borough of Wood-Ridge, and the undeveloped fill area).
- Air monitoring will consist of 3 stations, 2 samples per station, 2 field duplicates, and 1 field blank, for a total of 9 samples per event.
- The single layer cap in the undeveloped fill area will be a 4-inch-thick paved surface (assumed to be 2 inches of wear course and 2 inches of top coat). The sub-base material will be 6 inches thick.
- The existing paved areas and foundations in the developed area will provide an adequate engineering control, with applicable upgrades.
- Approximately 10 percent of additional top coat will be needed to regrade the developed area to promote surface water drainage.
- Soil removed from the Lin-Mor property will be placed in the undeveloped fill area and capped. It has been assumed that no additional permitting will be required to place the soil in the undeveloped fill area, and that the excavation will not cause an unsafe condition to the adjacent railroad.
- Soil in the area of the drain line removal will be placed back into the trench and capped, unless sample results indicate additional treatment is required or that the soil must be disposed of in a different manner.
- Soil within the 55-foot buffer will be excavated to a depth of 4 feet and placed below the undeveloped fill area cap. Certified clean fill material will be used to replace the excavated material within the 55-foot buffer. It has been assumed that no additional treatment will be required for the soil, and that analytical results of soil samples from

these areas will not exceed 620 mg/kg for mercury, which would require offsite treatment and disposal.

- Approximately 1 foot of soil will be excavated from the West Ditch. Certified clean fill material will be placed above a geomembrane liner and re-vegetated to promote restoration of habitat.
- It has been assumed that approximately 2,100 cubic yards of soil will be generated from the excavation in the undeveloped fill area for treatment and subsequent disposal at an offsite landfill.
- A sampling allowance, based on cubic yards of excavated material, has been included to account for sampling activities and analytical costs related to conformance sampling. Specific sampling requirements developed during the work planning and predesign phases of the project will include pre-excavation and post-excavation confirmatory sampling as necessary based on agency review. Samples will be collected in accordance with NJDEP sampling procedures, and soil samples will be analyzed by a New-Jersey-certified laboratory.
- For cost estimating purposes, it has been assumed the density of generated soil is 1.5 tons per cubic yard.
- For cost estimating purposes, it has been assumed the backfill volume will be 20 percent more than the excavated volume to account for compaction.
- Costs for dust and mercury vapor control have been included during the excavation activities.
- No additional surface water containment or erosion controls will be necessary for the undeveloped fill area.
- One percent of the cap areas will need to be repaired on an annual basis (both the existing and new cap).
- Approximately 30 percent of the cap areas will need to be repaired at year 30.

Soil Media Alternative 4—Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC. The objective of Soil Media Alternative 4 (S4) is to meet the RAOs by: (1) the excavation of soil with concentrations of mercury over 620 mg/kg in both the developed and undeveloped fill areas, (2) excavation of soil within the 55-foot buffer area for placement in the undeveloped fill area, (3) lining of the West Ditch, (4) placing a single layer cap over the undeveloped fill area (after excavation) and on the EJB property, (5) excavation of the Lin-Mor property for placement under the cap in the undeveloped fill area, and (6) using the existing caps (with upgrades) for the developed area. Figure 4-4 presents the location of the proposed excavations and the areas that will be capped under this alternative. As with Soil Alternative S2, the drain line within the undeveloped fill area will be located and removed before the installation of the cap.

The soil remedial objectives are met by Soil Alternative S4 through preventing direct contact to impacted soil, preventing continued erosion of contaminated soil, eliminating potential migration through surface water runoff, and minimizing leaching to groundwater. The main components of this alternative are:

- Land use restrictions
- Air Monitoring
- Grading
- Asphalt and building foundation caps (existing)
- Single layer cap (new)
- Excavation (drain line removal)
- Excavation (Lin-Mor; Developed and Undeveloped Fill Areas with ≥ 620 mg/kg mercury soil)
- Excavation (55-foot buffer)
- Capping of the West Ditch
- Treatment (soil characteristically hazardous for Hg)
- Soil reuse (55-foot buffer and Lin-Mor soils)
- Offsite disposal

The components of Soil Alternative S4 are discussed below.

Land Use Restrictions. The land use restrictions will be implemented as described in Soil Alternative S2. If a notice of intent for a deed notice(s) from an adjacent property(ies) is not obtained prior to remedial construction, that property(ies) will be excavated to the RDCSCC for the site's COCs.

Air Monitoring. Biennial air monitoring in the Wolf Warehouse will be conducted as described in Soil Alternative S2.

Grading. Grading, as necessary to promote cap installation and drainage will be implemented as described in Soil Alternative S2. It is anticipated the same equipment used to remove the drain line in the undeveloped fill area will also be used for grading.

Asphalt Cap (Existing). The asphalt and building foundation caps for the developed area (the U.S. Life and Wolf Warehouses, the paved parking areas, and the Borough of Wood-Ridge roadways) will be upgraded and maintained as described in Soil Alternative S2. These activities will be completed after excavation of soil exceeding 620 mg/kg for mercury (as discussed below).

Single Layer Cap. The single layer cap for the undeveloped fill area and the EJB property will be implemented as described in Soil Alternative S2. This cap will be installed after the drain line removal, placement of excavated soil from the Lin-Mor property, and excavation of soil with mercury concentrations exceeding 620 mg/kg (discussed below). The excavation area will also be capped after it is backfilled with clean material.

Excavation (Drain Line Removal). The drain line removal will be implemented as described in Soil Alternative S2. This activity will be completed concurrent with the excavation of soil discussed below.

Excavation (Lin-Mor; Developed and Undeveloped Fill Areas with ≥ 620 mg/kg Mercury Soil). The impacted target areas on the Lin-Mor property will be removed and placed in the undeveloped fill area to be capped as discussed in Soil Alternative S2. Soil with mercury concentrations exceeding 620 mg/kg will be excavated in both the developed and undeveloped fill areas. The area proposed for excavation in the undeveloped fill area is the same as discussed in Soil Alternative S3. The excavation proposed in the developed area is along the northeastern portion of Wolf Warehouse, at two isolated target areas on the northwestern portion of the U.S. Life Warehouse property, and one isolated location near the southwest corner of the Wolf Warehouse (Figure 4-4).

These areas include surface and subsurface excavations at the Wolf Warehouse, and only shallow soil excavations near the U.S. Life Warehouse. The excavations in the developed area will result in removal of approximately 5,040 cubic yards of mercury-impacted soil, and the excavations within the undeveloped fill area will result in removal of approximately 2,100 cubic yards of mercury-impacted soil. The volume of mercury-impacted subsurface soil requiring excavation is approximately 7,140 cubic yards.

For cost estimating purposes, it has been assumed that the entire undeveloped fill area excavation will be to a depth of 4 feet, and target areas within the developed area will range from 2 to 4 feet, depending on the depth of mercury seen during the RI; however, the depth may change based on data collected during remedial design. Additionally, it is assumed that no benching and/or shoring will be required at the 4-foot excavation depth; however, these details will be further evaluated during the design phase of the project.

Before any excavation begins, clearing and grubbing will be required as discussed in Soil Alternative S3. Based on the depths of the excavation, it is not anticipated that geotechnical stabilization of the excavation footprint will be necessary. The excavation will be sloped (assumed to be a 2:1 sloping), if necessary, during the excavation.

The excavation areas will be backfilled with certified clean fill material. The backfill will be similar in properties (porosity, grain size) as the native material. The backfilled material will be compacted and will be finished flush with the existing ground surface to promote capping. It has been assumed an additional 20 percent of clean fill will be needed to compact the excavation footprint to grade.

Temporary stormwater diversion and soil erosion and sediment control measures will be established before excavation. Staging areas will be created, as necessary, to allow for temporary stockpiling of soil during excavation, before loading. The areas will be bermed and lined in accordance with the stormwater control measures.

Excavation (55-Foot Buffer). Soil within the 55-foot buffer will be excavated and placed under the undeveloped fill area cap as discussed in Soil Alternative S2. Certified clean fill material be placed in the excavated 55-foot buffer, and native vegetation and erosion controls will be installed to stabilize the fill and minimize erosion. As with Soil Alternative S2, it has been assumed that, for cost estimating purposes, soil generated within the 55-foot buffer will not require treatment before placement in the undeveloped fill area, and will not have concentrations of mercury exceeding 620 mg/kg, which will require treatment and disposal.

Capping of the West Ditch. Capping of the West Ditch will be completed using a geomembrane liner material as discussed in Soil Alternative S2. The details of the floodplain evaluation, as discussed in Soil Alternative S2, will also be completed on the

West Ditch to determine any required changes to the floodplain to manage tidal surface water flow.

Treatment (Soil Characteristically Hazardous for Mercury). Soil generated during the excavation from the developed and undeveloped fill areas (assumed to be 7,140 cubic yards) with mercury exceeding 620 mg/kg will be treated, if necessary, and disposed of at an offsite landfill. Offsite stabilization and offsite disposal of the treated soil were assumed for cost estimating purposes. A treatability study will be completed during the design phase to assess the effectiveness of stabilization. If stabilization of mercury-impacted soil to treatment levels required by an applicable standard or appropriately issued variance is not practical, other treatment options will be explored, including retorting and soil washing.

Soil Reuse (55-Foot Buffer). As with Soil Alternative S2, soil excavated within the 55-foot buffer will be placed in the undeveloped fill area for capping. Soil sampling will be completed on this soil before placement to ensure the soil can be reused at the site without any additional treatment or offsite disposal.

Offsite Disposal. Soil generated from the West Ditch will be disposed of at a nonhazardous waste landfill. It has been assumed, for costing purposes, that no additional treatment is necessary for this soil, and that the soil will not be characteristically hazardous after sampling.

Cost Estimate Assumptions

The following are the assumptions used for cost estimating purposes as part of the FS, and may be changed during predesign studies or the remedial design:

- Eight Deed Notices will be prepared (assumed one each for the EJB property, the Norfolk Southern property, the U.S. Life Warehouse, the Wolf Warehouse, the Blum property, the Prince Packing property, the Borough of Wood-Ridge and the undeveloped fill area).
- Air monitoring will consist of 3 stations, 2 samples per station, 2 field duplicates, and 1 field blank, for a total of 9 samples per event.
- The single layer cap in the developed (where excavated) and undeveloped fill areas will be a 4-inch-thick paved surface (assumed to be 2 inches of wear course and 2 inches of top coat). The sub-base material will be 6 inches thick.
- The existing paved areas and foundations in the developed area will provide an adequate engineering control, with applicable upgrades.
- Approximately 10 percent of additional top coat will be needed to regrade the developed area to promote surface water drainage.
- Soil in the area of the drain line removal will be placed back into the trench and capped unless sample results indicate additional treatment is required or that the soil must be disposed of in a different manner.
- Soil within the 55-foot buffer will be excavated to a depth of 4 feet and placed below the undeveloped fill area cap. Certified clean fill material will be used to replace the

excavated material within the 55-foot buffer. It has been assumed that no additional treatment will be required for the soil, and that analytical results of soil samples from these areas will not exceed 620 mg/kg for mercury.

- Approximately 1 foot of soil will be excavated from the West Ditch. Certified clean fill material will be placed above and below a geomembrane liner and re-vegetated to promote restoration of habitat.
- It has been assumed that approximately 7,140 cubic yards of soil with mercury concentrations ≥ 620 mg/kg will be generated from the excavations for treatment and subsequent disposal at an offsite landfill.
- A sampling allowance, based on cubic yards of excavated material, has been included to account for sampling activities and analytical costs related to conformance sampling. Specific sampling requirements developed during the work planning and predesign phases of the project will include pre-excavation and post-excavation confirmatory sampling as necessary based on agency review. Samples will be collected in accordance with NJDEP sampling procedures, and soil samples will be analyzed by a New-Jersey-certified laboratory.
- For cost estimating purposes, it has been assumed that the density of generated soil is 1.5 tons per cubic yard.
- For cost estimating purposes, it has been assumed the backfill volume will be 20 percent more than the excavated volume to account for compaction.
- Costs for dust and mercury vapor control have been included during the excavation activities.
- No additional surface water containment or erosion controls will be necessary for the undeveloped fill area.
- One percent of the cap areas will need to be repaired on an annual basis (both the existing and new cap).
- Approximately 30 percent of the cap areas will need to be repaired at year 30.

Soil Media Alternative 5—Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Excavation of Other Properties to RDCSCC, and Use Restrictions on Undeveloped and Developed Areas. The objective of Soil Media Alternative 5 (S5) is to meet the RAOs by: (1) the excavation of soil with concentrations of mercury over 620 mg/kg in both the developed and undeveloped fill areas, (2) excavation of soil within the 55-foot buffer area for placement in the undeveloped fill area, (3) lining of the West Ditch, (4) placing a single layer cap over the undeveloped fill area (after excavation), (5) excavation of the Blum, Prince, Lin-Mor, Borough of Wood-Ridge, and EJB properties to RDCSCC and placement of excavated material under the cap in the undeveloped fill area, and (6) using the existing caps (with upgrades) for the developed area. Figure 4-5 presents the location of the proposed excavations and the areas that will be capped under this alternative. As with Soil Alternative S2, the drain line within the undeveloped fill area will be located and removed before the installation of the cap.

The soil remedial objectives are met by Soil Alternative S5 through preventing direct contact to impacted soil, preventing continued erosion of contaminated soil, eliminating potential migration through surface water runoff, and minimizing leaching to groundwater. The main components of this alternative are:

- Land use restrictions
- Air Monitoring
- Grading
- Asphalt and building foundation caps (existing)
- Single layer cap (new)
- Excavation (drain line removal)
- Excavation (soil)
- Excavation (55-foot buffer)
- Capping of the West Ditch
- Treatment (soil characteristically hazardous for Hg)
- Soil reuse (55-foot buffer, EJB, Blum, Prince, Lin-Mor, and Borough of Wood-Ridge soils)
- Offsite disposal

The components of Soil Alternative S4 are discussed below.

Land Use Restrictions. The land use restrictions will be implemented as described in Soil Alternative S2 for the U.S. Life Warehouse, Wolf Warehouse, Norfolk Southern, and undeveloped fill area properties.

Air Monitoring. Biennial air monitoring in the Wolf Warehouse will be conducted as described in Soil Alternative S2.

Grading. Grading, as necessary to promote cap installation and drainage will be implemented as described in Soil Alternative S2. It is anticipated the same equipment used to remove the drain line in the undeveloped fill area will also be used for grading.

Asphalt Cap (Existing). The asphalt and building foundation caps for the developed area (the U.S. Life and Wolf Warehouses and the paved parking areas) will be upgraded and maintained as described in Soil Alternative S2. These activities will be completed after excavation of soil exceeding 620 mg/kg for mercury (as discussed below).

Single Layer Cap. The single layer cap for the undeveloped fill area will be implemented as described in Soil Alternative S2. This cap will be installed after the drain line removal; placement of excavated soil from the Blum, Prince Packing, Lin-Mor property, Borough of Wood-Ridge, and EJB properties; and excavation of soil with mercury concentrations exceeding 620 mg/kg (discussed below). The excavation areas in the developed area will also be capped after being backfilled with clean material.

Excavation (Drain Line Removal). The drain line removal will be implemented as described in Soil Alternative S2. This activity will be completed concurrent with the excavation of soil discussed below.

Excavation (Soil). On the Blum, Prince Packing, Lin-Mor, Borough of Wood-Ridge, and EJB properties, the excavations will be to an approximate depth of 2 feet bgs. The excavated soil will be placed in the undeveloped fill area to be capped. The soil from this area (assumed to be approximately 6,800 cubic yards) will be compacted in the undeveloped fill area before installation of the cap. Excavation to the RDCSCC values will allow for unrestricted use of these properties in the future.

Soil with mercury concentrations exceeding 620 mg/kg will be excavated in both the developed and undeveloped fill areas. The area proposed for excavation in the undeveloped fill area is the same as discussed in Soil Alternative S3. The excavation proposed in the developed area is along the northeastern portion of Wolf Warehouse, at two isolated target areas on the northwestern portion of the U.S. Life Warehouse property, and one isolated location near the southwest corner of the Wolf Warehouse (Figure 4-5).

These areas include surface and subsurface excavations at the Wolf Warehouse, and only shallow soil excavations near the U.S. Life Warehouse. The excavations in the developed area will result in removal of approximately 5,050 cubic yards of mercury-impacted soil, and the excavations within the undeveloped fill area will result in removal of approximately 2,100 cubic yards of mercury-impacted soil. The volume of mercury-impacted subsurface soil requiring excavation is approximately 7,140 cubic yards.

For cost estimating purposes, it has been assumed that the entire undeveloped fill area excavation will be to a depth of 4 feet, and target areas within the developed area will range from 2 to 4 feet, depending on the depth of mercury seen during the RI; however, the depth may change based on data collected during remedial design. Additionally, it is assumed that no benching and/or shoring will be required at the 4-foot excavation depth; however, these details will be further evaluated during the design phase of the project.

Before any excavation begins, clearing and grubbing will be required as discussed in Soil Alternative S3. Based on the depths of the excavation, it is not anticipated that geotechnical stabilization of the excavation footprint will be necessary. The excavation will be sloped (assumed to be a 2:1 sloping), if necessary, during the excavation.

The excavation areas will be backfilled with certified clean fill material. The backfill will be similar in properties (porosity, grain size) as the native material. The backfilled material will be compacted and will be finished flush with the existing ground surface to promote capping. It has been assumed an additional 20 percent of clean fill will be needed to compact the excavation footprint to grade.

Temporary stormwater diversion and soil erosion and sediment control measures will be established before excavation. Staging areas will be created, as necessary, to allow for temporary stockpiling of soil during excavation, before loading. The areas will be bermed and lined in accordance with the stormwater control measures.

Excavation (55-Foot Buffer). Soil within the 55-foot buffer will be excavated and placed under the undeveloped fill area cap as discussed in Soil Alternative S2.

Capping of the West Ditch. Capping of the West Ditch will be completed using a geomembrane liner material as discussed in Soil Alternative S2. The details of the floodplain evaluation, as discussed in Soil Alternative S2, will also be completed on the West Ditch to determine any required changes to the floodplain to manage tidal surface water flow.

Treatment (Soil Characteristically Hazardous for Mercury). Soil generated during the excavation (assumed to be 7,140 cubic yards) with mercury exceeding 620 mg/kg will be treated as necessary and disposed of at an offsite landfill. Offsite stabilization and offsite disposal of the treated soil were assumed for cost estimating purposes. A treatability study will be completed during the design phase to assess the effectiveness of stabilization. If stabilization of mercury-impacted soil to treatment levels required by an applicable standard or appropriately issued variance is not practical, other treatment options will be explored, including retorting and soil washing.

Soil Reuse (55-Foot Buffer). As with Soil Alternative S2, soil excavated within the 55-foot buffer will be placed in the undeveloped fill area for capping. Soil sampling will be completed on this soil before placement to ensure the soil can be reused at the site without any additional treatment or offsite disposal.

Offsite Disposal. Soil generated from the West Ditch will be disposed of at a nonhazardous waste landfill. It has been assumed, for costing purposes, that no additional treatment is necessary for this soil, and that the soil will not be characteristically hazardous after sampling.

Cost Estimate Assumptions

The following are the assumptions used for cost estimating purposes as part of the FS, and may be changed during predesign studies or the remedial design:

- Four Deed Notices will be prepared (assumed one each for the U.S. Life Warehouse, the Wolf Warehouse, Norfolk Southern, and the undeveloped fill area).
- Air monitoring will consist of 3 stations, 2 samples per station, 2 field duplicates, and 1 field blank, for a total of 9 samples per event.
- The single layer cap in the undeveloped fill area and the developed area where excavation occurs will be a 4-inch-thick paved surface (assumed to be 2 inches of wear course and 2 inches of top coat). The sub-base material will be 6 inches thick.
- The existing paved areas and foundations in the developed area will provide an adequate engineering control, with applicable upgrades.
- Approximately 10 percent of additional top coat will be needed to regrade the developed area to promote surface water drainage.
- Soil in the area of the drain line removal will be placed back into the trench and capped unless sample results indicate additional treatment is required or that the soil must be disposed of in a different manner.
- Soil within the 55-foot buffer will be excavated to an average depth of 4 feet and placed below the undeveloped fill area cap. Certified clean fill material will be used to replace the excavated material within the 55-foot buffer. It has been assumed that no additional treatment will be required for the soil, and that analytical results of soil samples from these areas will not exceed 620 mg/kg for mercury.

- Approximately 1 foot of soil will be excavated from the West Ditch. Certified clean fill material will be placed above a geomembrane liner and re-vegetated to promote restoration of habitat.
- It has been assumed that approximately 7,140 cubic yards of soil with mercury concentrations ≥ 620 mg/kg will be generated from the excavations for treatment and subsequent disposal at an offsite landfill.
- The shallow depth of the excavation on the Blum, Prince Packing, Lin-Mor, Borough of Wood-Ridge, and EJB properties will not necessitate any disruptions to, replacement of, or repair to any utilities. The estimated excavation volume for these properties is 6,800 cubic yards
- For cost estimating purposes, it has been assumed that the density of generated soil is 1.5 tons per cubic yard.
- For cost estimating purposes, it has been assumed the backfill volume will be 20 percent more than the excavated volume to account for compaction.
- A sampling allowance, based on cubic yards of excavated material, has been included to account for sampling activities and analytical costs related to conformance sampling. Specific sampling requirements developed during the work planning and predesign phases of the project will include pre-excavation and post-excavation confirmatory sampling as necessary based on agency review. Samples will be collected in accordance with NJDEP sampling procedures, and soil samples will be analyzed by a New-Jersey-certified laboratory.
- Costs for dust and mercury vapor control have been included during the excavation activities.
- No additional surface water containment or erosion controls will be necessary for the undeveloped fill area.
- One percent of the cap areas will need to be repaired on an annual basis (both the existing and new cap).
- Approximately 30 percent of the cap areas will need to be repaired at year 30.

Soil Media Alternative 6—Excavation of Developed Area with ≥ 620 mg/kg Mercury, Excavation of Undeveloped Area and Other Properties to RDCSCC, and Use Restrictions on Developed Area. Soil Media Alternative 6 (S6) includes: (1) excavation of soil with concentrations of mercury ≥ 620 mg/kg in the developed area, (2) excavation of the mercury-impacted soil in the undeveloped fill area (approximately 122,500 cubic yards of impacted soil) for treatment (as necessary) and offsite disposal, (4) excavation of the Blum, Prince Packing, Lin-Mor, Borough of Wood-Ridge, and EJB properties to RDCSCC for offsite disposal, (4) excavation of soil within the 55-foot buffer area for offsite disposal, (5) excavation and lining of the West Ditch, and (6) using the existing caps (with upgrades) for the developed area. The excavation areas for Soil Alternative S6 are depicted in Figure 4-6. Because of the elevated levels of arsenic, lead, and mercury in subsurface soil in the undeveloped fill area, it has been assumed the excavation will extend approximately 4 feet bgs to the approximate depth of the water table. The U.S. Life and Wolf Warehouses and the railroad property will be capped as presented in Soil Alternative S2. The assumptions on the depth of excavation were made for costing purposes, and may change as a result of predesign studies performed in support of a detailed remedial design.

This alternative meets the RAOs by removing contaminated soil and eliminating contact with the remaining soil contamination. Treatment of the soil before disposal will be used to meet the treatment standards and allow for disposal at a nonhazardous waste or hazardous waste landfill, as applicable. The major remedial components of Soil Alternative S6 are the following:

- Land use restrictions
- Air monitoring
- Grading
- Asphalt and building foundation caps (existing)
- Excavation (drain line removal)
- Excavation (soil)
- Excavation (55-foot buffer)
- Capping of the West Ditch
- Treatment (soil characteristically hazardous for Hg)
- Backfill
- Offsite disposal

The components of this alternative are presented below.

Land Use Restrictions. The land use restrictions will be implemented as described in Soil Alternative S2 for the U.S. Life Warehouse, Wolf Warehouse, and the Norfolk Southern properties.

Air Monitoring. Biennial air monitoring in the Wolf Warehouse will be conducted as described in Soil Alternative S2.

Grading. Grading, as necessary to promote cap installation and drainage, will be implemented as described in Soil Alternative S2. It is anticipated that the same equipment used to remove the drain line and soil in the undeveloped fill area will also be used for grading.

Asphalt Cap (Existing). The asphalt and building foundations caps for the developed area (the U.S. Life and Wolf Warehouses, the paved parking areas, and the railroad) will be upgraded and maintained as described in Soil Alternative S2.

Excavation (Drain Line Removal). The drain line removal will be implemented as described in Soil Alternative S2. This activity will be completed concurrent with the excavation of the undeveloped fill area.

Excavation (Soil). The excavation proposed in the developed area is the same as that presented in Soil Alternative S5. The excavation of impacted soil in the undeveloped fill area will be completed using standard equipment (backhoes, front-end loaders, etc.) to an approximate depth of 4 feet in an attempt to remove impacted soil within the undeveloped fill area to RDCSCC. Clearing and grubbing will be completed before the excavation activities as described in Soil Alternative S3. On the Blum, Prince Packing, Lin-Mor, Borough of Wood-Ridge, and EJB properties, the excavation procedures will be the same as those presented in Soil Alternative S5. The departure from Soil Alternative S5 is that for Soil Alternative S6 the excavated soil will be disposed of offsite, along with soil generated in the undeveloped fill area. It has been assumed that soil from the Blum, Prince Packing, Lin-Mor, Borough of Wood-Ridge, and EJB properties will be nonhazardous and will not require treatment before disposal at an offsite landfill.

Temporary stormwater diversion and soil erosion and sediment control measures will be established before all excavation. As necessary, staging areas will be created to allow for temporary stockpiling of soil during excavation. The areas will be bermed and lined in accordance with the stormwater control measures. Costs for wetlands mitigation along the West Ditch are also included. Mitigation would be required in this area because of the disturbance of the wetlands.

The excavation areas will be backfilled with clean, certified fill material. The backfill will be similar in properties (porosity, grain size) as the native material. The backfilled material will be compacted in lifts (assumed to be 1- to 2-foot lifts, to be determined during design) to the ground surface. It has been assumed that an additional 20 percent of clean fill will be needed to compact the excavation footprint to grade.

Applicable sediment control measures will also be implemented within Berry's Creek during the excavation to ensure the excavation will not adversely impact surface water or sediment. As previously stated, the assumptions presented above have been made for costing purposes, and may change during the predesign studies or remedial design.

Excavation (55-Foot Buffer). Soil within the 55-foot buffer will be excavated and disposed of offsite. The excavation of the soil will be completed concurrently with the excavation of the undeveloped fill area.

Capping of the West Ditch. Capping of the West Ditch will be completed using concrete precast channels. It has been assumed that, for cost estimating purposes, approximately 1 foot of soil will need to be removed from the ditch before placement of the concrete channels so the elevation of the channel is not changed.

Treatment (Soil Characteristically Hazardous for Mercury). Soil generated during the excavation in the undeveloped fill area that is characteristically hazardous for mercury will be treated, as required by LDRs, before disposal. For cost estimating purposes, 100 percent of the soil excavated from the developed area and 75 percent of the soil excavated in the undeveloped fill area has been assumed to be characteristically hazardous (approximately 5,050 cubic yards and 92,000 cubic yards, respectively); 25 percent of the soil from the undeveloped fill area is assumed to be nonhazardous (approximately 30,500 cubic yards). The actual volume of characteristically hazardous soil in the undeveloped area would be determined during pre-excavation sampling confirmation activities and may vary from the 75 percent assumption discussed here. There are also additional compounds (such as compounds usually seen in contaminated historic fill) that may require treatment to meet LDRs or landfill requirements that would dictate treatment. In the developed area excavations (Blum, Prince Packing, Lin-Mor, Borough of Wood-Ridge, and EJB properties), it has been assumed that all soil will be nonhazardous.

Offsite Disposal. It has been assumed that, for cost estimating purposes, approximately 5,050 cubic yards of soil from the developed area and approximately 92,000 cubic yards of soil from the undeveloped fill area will be stabilized and disposed of at a hazardous waste landfill. The remaining material from the undeveloped fill area is assumed to be non-hazardous, including the material excavated from the West Ditch during rehabilitation, and will be shipped to a nonhazardous waste landfill. The actual amounts of impacted soil disposed of at hazardous on non-hazardous landfills will be based upon results of characterization of the excavated soil prior to shipment. Excavated material from the Blum, Prince Packing, Lin-Mor, Borough of Wood-Ridge, and EJB properties are also assumed to be nonhazardous and will be shipped to a nonhazardous waste landfill.

Cost Estimate Assumptions

The following are the assumptions used for cost estimating purposes as part of the FS, and may be changed during predesign studies or the remedial design:

- Three Deed Notices will be prepared (assumed one each for the Norfolk Southern, U.S. Life Warehouse, and Wolf Warehouse properties).
- Air monitoring will consist of 3 stations, 2 samples per station, 2 field duplicates, and 1 field blank for a total of 9 samples per event.
- 25 percent of soil impacted with mercury from the undeveloped fill area (30,500 cubic yards) will not require treatment before disposal in a nonhazardous waste landfill.
- 75 percent of the mercury-impacted soil from the undeveloped fill area (92,000 cubic yards) will require stabilization/treatment before disposal in a hazardous waste landfill.
- The shallow depth of excavation on the Blum, Prince Packing, Lin-Mor, Borough of Wood-Ridge, and EJB properties will not necessitate any disruptions to, replacement of, or repair to any utilities.
- It has been assumed that soil generated on the Blum, Prince Packing, Lin-Mor, Borough of Wood-Ridge, and EJB properties (approximately 6,800 cubic yards) will be nonhazardous and disposed of at a nonhazardous waste landfill.
- The excavated soil from the developed area (5,040 cubic yards) is assumed to be hazardous and will be disposed at a hazardous waste landfill.
- For cost estimating purposes, it has been assumed the density of generated soil is 1.5 tons per cubic yard.
- For cost estimating purposes, it has been assumed the backfill volume will be 20 percent more than the excavated volume to account for compaction.
- A sampling allowance, based on cubic yards of excavated material, has been included to account for sampling activities and analytical costs related to conformance sampling. Specific sampling requirements developed during the work planning and predesign phases of the project will include pre-excavation and post-excavation confirmatory sampling as necessary based on agency review. Samples will be collected in accordance

with NJDEP sampling procedures, and soil samples will be analyzed by a New-Jersey-certified laboratory.

- Costs for mercury and dust control during excavation activities have been included.
- The existing paved areas and foundations will provide an adequate engineering control, with applicable upgrades.
- It has been assumed that the excavation adjacent to the Blum and Prince Packing facilities will not cause unsafe conditions in the existing warehouses.
- No additional surface water containment or erosion controls will be necessary for the undeveloped fill area.
- One percent of the existing cap areas will need to be repaired on an annual basis.
- Approximately 30 percent of the cap areas will need to be repaired at year 30.

Soil Media Alternative 7—Excavation of Undeveloped, Developed, and Other Properties to RDCSCC and Use Restrictions on the Railroad. The objectives of Soil Media Alternative 7 (S7) are to: (1) excavate mercury-impacted soil over the entire site (excluding any potentially impacted soil under the rail spur located to the south of the U.S. Life and Wolf warehouses in the developed area), and (2) remove 4 feet of soil in the adjacent West Ditch. The locations of the excavation are depicted in Figure 4-7. This alternative meets the RAOs by removal and offsite disposal of soil with COCs over the PRGs.

The major remedial components of alternative S5 are the following:

- Grading
- Excavation (drain line removal)
- Excavation (soil)
- Excavation (55-foot buffer)
- Excavation of the West Ditch
- Treatment (soil characteristically hazardous for mercury)
- Backfill
- Offsite disposal

The components of this alternative are presented below.

Land Use Restrictions. Land use restrictions will be implemented as described in Soil Alternative S2 for the Norfolk Southern property.

Grading. Grading, as necessary to promote drainage, will be implemented after each area has been backfilled. It is anticipated that grading will be completed after removal of all impacted soil and will be based on proposed future use of the areas.

Excavation (Drain Line Removal). The drain line removal will be implemented as described in Soil Alternative S2. This activity will be completed concurrent with the excavation of the undeveloped fill area.

Excavation (Soil). The excavation of Site soil with COCs exceeding PRGs will be completed using standard equipment (backhoes, front-end loaders, etc.) to an approximate depth of

4 feet. The total volume of soil to be generated is assumed to be approximately 157,500 cubic yards in the developed and undeveloped fill areas. Additional excavation procedures, stormwater and soil erosion controls, and clearing and grubbing are the same as those presented in Soil Alternative S3. Excavation of the developed area will also require the removal of existing structures and utilities, most of which are active, operating facilities. Costs for removal of these buildings and utilities are also included within this alternative. It has been assumed the buildings and streets (Ethel Boulevard and Park Place East) will be replaced after excavation and backfilling. The railroad spur located north of Ethel Boulevard and the undeveloped fill area was constructed prior to 1963 (based on aerial photographs from the RI). Since the existence of the rail spur predates the demolition of the manufacturing building (circa 1974), it was not constructed on soils impacted by the demolition and will not be removed as part of this excavation. Furthermore, the ballast material creating the base for the railroad tracks acts as a cap preventing direct contact and migration of any impacted soil beneath the tracks, if existing. The rail spur to the south of the U.S. Life and Wolf warehouses will be demolished.

Excavated areas will be backfilled as described in Soil Alternative S6. Assumptions stated in this alternative were made for cost estimating purposes, and may be changed during remedial design.

Excavation (55-Foot Buffer). Soil within the 55-foot buffer will be excavated and disposed of offsite. The excavation of the soil will be completed concurrently with the excavation of the undeveloped fill area.

Excavation (West Ditch). As part of the excavation of the entire site, the West Ditch will be excavated to a depth of 4 feet. The excavation will be completed using standard equipment (backhoes, front-end loaders, etc.), and will be implemented concurrently with the excavation of the undeveloped fill area. A 4-foot-depth of excavation was chosen based on the depth required for excavation in the undeveloped fill area. After excavation, certified clean fill material will be placed back into the ditch and graded to promote drainage. During these activities, a coffer dam may be required at the confluence of the West Ditch and the Diamond Shamrock/Henkel (north) to control water.

Costs for wetlands mitigation along the West Ditch are also included in this alternative. Mitigation would be required in these areas because of the disturbance of the wetlands.

Treatment (Soil Characteristically Hazardous for Mercury). Soil generated during the excavations that is characteristically hazardous for mercury will be treated, as required by LDRs, before disposal. For cost estimating purposes, it is assumed, therefore, that 75 percent of the soil excavated in the developed and undeveloped fill areas (a total of 157,500 cubic yards) will be hazardous (118,000 cubic yards). There are also additional compounds (such as those typically seen in contaminated historic fill) that may require treatment to meet LDRs or landfill requirements that would dictate treatment.

Offsite Disposal. It has been assumed that, for cost estimating purposes, approximately 25 percent of the soil generated in this alternative (25 percent of the 157,500 cubic yards of soil from the entire site and all of the 1,800 cubic yards from the West Ditch) will be disposed of at a nonhazardous waste landfill. Based on this assumption, approximately 41,000 cubic yards of material will be shipped to a nonhazardous waste landfill. The actual amounts of impacted soil disposed at hazardous or non-hazardous landfills will be based upon results of characterization of the excavated soil prior to shipment.

Cost Estimate Assumptions

The following are the assumptions used for cost estimating purposes as part of the FS, and may be changed during predesign studies performed in support of the detailed remedial design:

- 25 percent of soil impacted with mercury (approximately 41,000 cubic yards) will not require treatment before disposal in a nonhazardous waste landfill.
- A total of 118,000 cubic yards of material will be treated and shipped to a permitted, hazardous waste landfill.
- For cost estimating purposes, it has been assumed that the density of generated soil is 1.5 tons per cubic yard.
- For cost estimating purposes, it has been assumed that the backfill volume will be 20 percent more than the excavated volume to account for compaction.
- A sampling allowance, based on cubic yards of excavated material, has been included to account for sampling activities and analytical costs related to conformance sampling. Specific sampling requirements developed during the work planning and predesign phases of the project will include pre-excavation and post-excavation confirmatory sampling as necessary based on agency review. Samples will be collected in accordance with NJDEP sampling procedures, and soil samples will be analyzed by a New-Jersey-certified laboratory.
- Costs for dust and mercury control during excavation activities have been included.
- The rail line north of Ethel Boulevard will not be removed to excavate the potentially impacted soil. Land use restrictions will be implemented for this property.
- The undeveloped fill area will be re-seeded and trees will be planted after excavation is completed.

4.2 Development of Groundwater Media Remedial Alternatives

Six groundwater media alternatives were developed to provide a range of remedial actions for groundwater contamination at the site. Each technology remaining after the screening process was incorporated into at least one alternative. Table 4-3 presents a matrix of technologies that survived screening and the alternatives into which they were incorporated.

As discussed in Section 2.2.2, the remedial action objectives for the groundwater alternatives are:

- Prevent/minimize the potential downgradient and offsite migration of contaminated groundwater to the marsh area and Berry's Creek

- Reduce human and ecological receptors' potential exposure to contaminants in groundwater to within acceptable risk levels

Below is a summary of each of the groundwater media alternatives.

Groundwater Media Alternative 1—No Further Action. The objective of Groundwater Alternative 1 (G1) is to provide a baseline for comparison to other alternatives, as required by the NCP. Groundwater Alternative G1 assumes no further remedial action for groundwater. It does not include monitoring or institutional controls. Because it serves as a baseline, it is assumed that this alternative will be paired with the Soil Alternative S1—No Further Action.

Groundwater Media Alternative 2—Natural Attenuation and Institutional Controls. The objective of Groundwater Alternative 2 (G2) is to rely on natural attenuation to reduce concentrations within the groundwater plume to below standards, while placing use restrictions on the area of groundwater exceeding PRGs. If monitoring data point to further spreading of the plume above remedial goals, active restoration with one of the remaining groundwater alternatives (G3, G4, G5, or G6) would be implemented. This alternative may be paired with soil remedial alternatives that either treat or remove the soil with the highest COC concentrations so that further mass flux to the plume would be minimal, thus decreasing substantially the time until natural attenuation achieves the remedial goals.

Groundwater Alternative G2 meets the RAOs by continuing to monitor groundwater conditions within the area of contamination and along the downgradient portion of the site. The main remedial components of G2 are:

- Groundwater use restrictions
- Groundwater monitoring
- Natural attenuation

Groundwater Use Restrictions. Institutional controls in New Jersey, in accordance with the NJDEP regulations (N.J.A.C. 7:26E-8.4) are designated as a CEA. The components of the CEA include the location of the restriction (which includes the potential migration locations before degradation reduces concentrations to below applicable cleanup criteria), the compounds detected over the applicable cleanup criteria within the restricted area, and the proposed duration of the restriction. This control will eliminate future use of the groundwater within this area and will restrict the installation of wells in the area for the duration of the CEA. The CEA will be submitted to, and approved by, NJDEP and placed within the New Jersey geographic information system database for the duration of the control.

Groundwater Monitoring. As part of this alternative, continued monitoring of groundwater will be completed to verify that: (1) natural attenuation is occurring and (2) the concentrations of COCs at perimeter wells (along Berry's Creek) continue to be below the GWQC. The monitoring wells that will be sampled to verify natural attenuation is continuing are listed in Table 4-4. For cost estimation purposes, it is assumed that the 15 existing monitoring wells (shown on Figure 2-8) will be monitored, assuming that they exist and are in good condition after the remedial action has occurred. The post-remediation monitoring network (number of wells, sampling locations, constituent analysis list) will be dependent on the final design. The utility of additional wells will be considered during the remedial design. After the remedy has been implemented and groundwater concentrations are stable, the monitoring network will be reevaluated. For costing purposes, it has been assumed that groundwater samples will be analyzed for total and dissolved mercury, arsenic, and benzene. It is anticipated that sampling will occur quarterly for the first 2 years after initiation of the remedial actions, and then be completed annually after that time.

Natural Attenuation. Natural attenuation is the process by which contaminant concentrations are reduced by volatilization, dispersion, adsorption, and/or biodegradation. Natural attenuation mechanisms for metals, such as mercury, are more limited because they are elements that do not degrade biologically. The primary mechanisms expected to contribute to the attenuation of mercury include adsorption and in situ precipitation.

Flux rates of inorganics from groundwater through soil to Berry's Creek and the Diamond-Shamrock/Henkel (north) Ditch with and without an impermeable cap over the undeveloped fill area were estimated by modeling differences in infiltration rates and water table characteristics. The flux rates of mercury and arsenic to Berry's Creek without a cap were first calculated using mercury concentrations measured during the 1999 sampling event and averages of arsenic concentrations measured in 1997 and 1999. Flux rates were then calculated for a limited-infiltration scenario (defined as a low-permeability cap, such as asphalt), to simulate flux differences caused by the installation of a cap over the undeveloped fill area. By limiting infiltration, the water table would change from the current "mounded" condition (higher water table elevations in the middle of the undeveloped fill area) to a more uniform slope from the developed area to Berry's Creek. Table 4-5 presents the calculated flux rates for mercury and arsenic with and without the simulated cap.

The evaluation of fluxes of inorganics from groundwater through soil to Berry's Creek and the Diamond Shamrock/Henkel Ditch (north) was done following completion of the original draft of the RI. Because the RI is an investigation of the conditions that exist at the site, it was determined that a flux evaluation was not appropriate to include in that report. Because the FS is an evaluation of the impact that various remedial actions would have on the site, inclusion of the flux calculations is more appropriate for this document.

The fluxes of inorganics from groundwater through soil to Berry's Creek and the Diamond Shamrock/Henkel Ditch (north) were estimated using the Dupuit equation for flow in an unconfined aquifer (Fetter, 1994) and represent pre-remediation conditions. Fluxes were estimated by multiplying the concentrations by the volume flow, which is a function of the hydraulic conductivity, the gradient and the width of the flow path. Hydraulic conductivities at the wells nearest to the surface water bodies were taken from Table 3-2 of the RI. Water elevations at the wells recorded from October 15, 1997 through June 19, 2000 (RI Table 3-1) were used with the depth to the clay/silt layer beneath the site (J.S. Ward, 1975) and the distances from the wells to Berry's Creek or the ditch to determine the gradients. The width of the flow paths between the wells is based on distances between the monitoring wells (RI, Figure 2-1a). Concentrations are taken from data collected in 1997 and 1999 (RI, Table B1-7a and B1-7e). Non-detect values were taken as being ½ the detection limit.

Average values for the parameters in the Dupuit equation were used to estimate fluxes. The range of hydraulic conductivity values is quite small, with maximum values being as much as 114% of the average. The range of gradient values is also small, with maximum values ranging up to 128% of the average. For mercury, the most current values (1999) were used in the flux calculations, so there is no difference between average and maximum values. Including the 1997 data, most of which are non-detect, would result in maximum mercury values as much as 9 times the average. For arsenic, maximum values range from 100% to 167% of the average values.

If one uses the maximum values for hydraulic conductivity, gradient and concentrations in the flux calculations, the following results are obtained:

Total flux to surface water:	Mercury	Arsenic
Current Conditions (without cap)		
Average Parameter Values	41 g/yr	583 g/yr
Maximum Parameter Values	60 g/yr	971 g/yr
Limited Recharge (with cap)		
Average Parameter Values	2.2 g/yr	36 g/yr
Maximum Parameter Values	3.9 g/yr	69 g/yr

Thus, using maximum values for all parameters, as opposed to average values, could result in fluxes of mercury and arsenic being from 1.5 to 2 times the fluxes based on average values.

Flux rates of both mercury and arsenic to Berry's Creek when infiltration is limited are approximately one order of magnitude less than the currently calculated flux rates. Conceptually, the flux rates would be even less, since infiltration will no longer be creating the current flow gradients between the undeveloped fill area and Berry's Creek. Flow rates would be lower, therefore, and lower masses of mercury and arsenic would be expected to flow to Berry's Creek each year. This modeling exercise indicates that a passive method (such as capping) to control plume migration to the creek would be effective in meeting the RAOs, and that more active methods (such as pump-and-treat) are unnecessary.

Through the implementation of any of the soil alternatives presented in Section 4.1 (with the exception of No Further Action), the infiltration of COCs will be reduced by either limiting infiltration (through capping options) or removal (through excavation options). Since the mass flux from groundwater to surface water and sediment would be reduced by an order of magnitude, it is presumed that natural attenuation (when coupled with soil capping alternatives such as Soil Alternative S2) is a viable technology for groundwater. The assumptions made above were developed for costing purposes, and may change during predesign studies or the remedial design.

Groundwater Media Alternative 3—Hydraulic Controls via Pumping. The objective of Groundwater Media Alternative 3 (G3) is to control the potential migration of impacted groundwater from the site to Berry's Creek. Groundwater will be intercepted before entering Berry's Creek using a series of extraction wells along the creek bank. The system will pump at a relatively low flow rate, and will be used primarily as a protective measure for downgradient groundwater quality rather than active COC removal. Concentrations of COCs in monitoring wells along the edge of Berry's Creek will be monitored as part of the natural attenuation component of this alternative. Because concentrations throughout most of the site are below MCLs, extracted groundwater is not expected to require significant treatment, if any, before discharge to the POTW.

This alternative will meet the RAOs by preventing downgradient migration of the plume, thereby protecting downgradient human and ecological receptors. The main remedial components of Groundwater Alternative G3 are:

- Groundwater use restrictions
- Groundwater monitoring
- Hydraulic controls via pumping
- Groundwater treatment (via filtration)
- Discharge to POTW

Groundwater Use Restrictions. Groundwater use restrictions will be implemented as described in Groundwater Alternative G2.

Groundwater Monitoring. During active pumping of the plume, groundwater quality upgradient, within, and downgradient of the plume extent will be monitored as described in Groundwater Alternative G2. Groundwater monitoring will also be used to determine the effectiveness of the hydraulic control system.

Hydraulic Controls via Pumping. This alternative will collect groundwater from the downgradient edge of the plume (adjacent to Berry's Creek and the Diamond Shamrock/Henkel (north) Ditch), to ensure no potential migration of contamination to receptors. Although the exact details of the pumping rates will be determined during predesign activities and during site pumping tests, an initial modeling effort was undertaken to estimate the approximate number of wells and rate of pumping required to intercept downgradient flow from the site. The analytical groundwater flow model, CAPZONE, was used in conjunction with the semi-analytical particle path model, GWPATH, to perform this analysis. The slightly irregular (mounded) potentiometric surface was used as input in the non-uniform gradient option of CAPZONE. The average estimated aquifer thickness, hydraulic conductivity, and potentiometric surfaces beneath the site were based on information provided in the RI Report for the site (Exponent, 2004b).

The model domain consists of 40 columns and 36 rows on 50-foot centers. The model domain extended approximately 2,000 feet by 1,800 feet. The 2002 water levels were used as input to CAPZONE along with the estimated thickness of the aquifer (approximately 18 feet). Hydraulic conductivity values developed from slug tests in 12 of the 15 monitoring wells ranged between 0.23 to 94 ft/day with a geometric mean of 13 ft/day. Based on the hydraulic conductivity and saturated thickness, a transmissivity of 1,800 gallons per day (gpd)/ft was used as input for CAPZONE, with an estimated storage coefficient (for an unconfined aquifer) of 0.25.

Based on the results of the flow model evaluation, five extraction wells will be installed to intercept downgradient flow. Pumping rates in the five wells will range from approximately 2 to 5 gallons per minute (gpm). The wells will be installed along the downgradient edge of the OU1 groundwater plume near the locations of monitoring wells MW-12, MW-3, MW-4, MW-1, and MW-6 (see Figure 4-8). If additional wells are shown to be necessary, they will be added. Total flow rates from the five wells will be approximately 10 to 25 gpm.

A flow rate of 20 gpm was assumed for costing purposes. Since this system is a passive hydraulic control system and is not designed to aggressively remove mercury, benzene, and arsenic from groundwater, it has been assumed that, for cost estimating purposes, the system will operate for 50 years.

It is assumed that submersible pumps will be used for groundwater extraction. The pumps will be operated by pressure transducers, which start and stop the submersible pump in each well depending on the water level depth. All of the pumps will be piped to a treatment system, which is assumed to be located near the Wolf Warehouse, with access to power and discharge locations (see Figure 4-8). The wells will be piped via underground conduits to eliminate the need for heat tracing or other freezing controls.

Treatment via Filtration. Potential influent concentrations of mercury, benzene, and arsenic were calculated based on concentrations at nearby monitoring wells and the flow rate of the individual extraction well. Groundwater data from the 2002 groundwater sampling event were used to estimate the average mercury, benzene, and arsenic concentrations in influent groundwater. The expected mercury influent concentration is approximately 0.04 μg/L. Details on the calculation are included in Table 4-6. The estimated average concentration of mercury (0.04 μg/L) is well below the required POTW discharge criterion as discussed below; the estimated benzene (5.0 μg/L) and arsenic (2.5 μg/L) concentrations are also lower than the POTW discharge criteria. Although the influent concentrations of mercury will be below the POTW treatment limits, GAC will be used as the ex situ treatment option to reduce concentrations of any spikes that may be encountered, and to treat the influent benzene and arsenic concentrations. GAC treatment was, therefore, assumed for the system before discharge to the POTW to ensure meeting discharge requirements for the three COCs. The assumptions described in this alternative were made for cost estimating purposes, and may be changed during predesign studies or the remedial design.

The GAC system will consist of 2 units (approximately 500 pounds each) that will be piped in series before discharge. The system will be placed in series to allow for monitoring the effectiveness of the first vessel and provide a backup with the second vessel. This method will also allow for the secondary vessel to be used during changeout of the primary vessel, which will eliminate downtimes.

It has been assumed that additional treatment for solids removal will be necessary before treatment with the GAC; therefore, the system will also include a series of green sand filters placed before the GAC units. These units will be piped in series before the GAC units for particulate removal. A conceptual layout of the system components for the GAC system is included in Table 4-7 and illustrated in Figure 4-9.

Discharge to POTW. Bergen County Utilities Authority (BCUA) has provisions for the discharge of groundwater to the POTW. The BCUA does not have local limits for mercury and arsenic, but refers to the NJDEP groundwater standards as a condition of its NJPDES permit to discharge to the Hackensack River. The estimated average benzene concentration (5 μg/L) is below the BCUA limit for benzene (850 μg/L). The estimated concentrations of mercury (0.04 μg/L) and arsenic (2.5 μg/L) are below the NJDEP groundwater standards of 2 and 8 μg/L, respectively. The BCUA enforces an Industrial Pretreatment Program (IPP) that controls the discharge of pollutants. The BCUA will require connection to the BCUA system and a Groundwater Discharge Permit or an Industrial Wastewater Discharge Permit

(Rules and Regulations for the Direct and Indirect Discharge of Wastewater to the Bergen County Utilities Authority Treatment Works). The proposed connection location is in the right-of-way of Park Place East, near the developed area.

Cost Estimate Assumptions

The following are the assumptions used for cost estimating purposes as part of the FS, and may be changed during predesign studies or the remedial design:

- The average concentrations of mercury, benzene, and arsenic in influent groundwater will be approximately 0.04 μg/L, 5 μg/L, and 2.5 μg/L, respectively.
- Although the influent concentrations of mercury will be below the POTW treatment limits, GAC will be used as the ex situ treatment option to reduce concentrations of any spikes that may be encountered, and to treat the influent benzene and arsenic concentrations.
- Since this system is a passive technology and requires that the entire plume eventually migrate into the area of collection, it will have to operate for 50 years to achieve RAOs.
- Since the levels of mercury, benzene, and arsenic are low in groundwater, it has been assumed that GAC changeout will only occur once every 2 years.
- The treatment system will be housed in a newly constructed building adjacent to the Wolf Warehouse. This location provides adequate access to power and discharge locations.

Groundwater Media Alternative 4—Groundwater Pump and Treat. The objective of Groundwater Alternative 4 (G4) is to aggressively remediate the plume by active removal of the contaminated groundwater for ex situ treatment and ultimate discharge. This alternative includes a series of extraction wells, placed throughout both the developed area and the undeveloped fill area, to collect the entire OU1 groundwater. After collection, the groundwater will be treated before discharge to the POTW.

The RAOs for groundwater are achieved through this alternative by preventing potential migration and/or human exposure to impacted groundwater. The main remedial components of Groundwater Alternative G4 are:

- Groundwater use restrictions
- Groundwater monitoring
- Collection via pumping
- Groundwater treatment via filtration and ion exchange
- Discharge to POTW

Groundwater Use Restrictions. Groundwater use restrictions will be implemented as described in Groundwater Alternative G2.

Groundwater Monitoring. Groundwater quality upgradient, within, and downgradient of the plume extent will be monitored, as described in Groundwater Alternative G2, during operations of the treatment system to verify the effectiveness of the system.

Collection via Pumping. The objective of this alternative is to actively pump the entire groundwater area exceeding the GWQC for collection, treatment, and disposal. Although details of the pumping rates will be determined during predesign activities and during site pump tests, an initial modeling effort was undertaken to estimate the approximate number of wells and rate of pumping required to intercept downgradient flow from the site. The analytical groundwater flow model, CAPZONE, was used in conjunction with the semi-analytical particle path model, GWPATH, to perform this analysis as discussed in Groundwater Alternative G3.

The five extraction wells proposed in Groundwater Alternative G3 will be used to capture the downgradient edge of the plume. Two additional extraction wells in the area of the U.S. Life, and Wolf Warehouses, respectively, will be installed to intercept the remainder of the contaminant plume (see Figure 4-10). Each of these two additional extraction wells will pump at approximately 3 to 5 gpm, for a network total pumping rate of 25 to 35 gpm. If additional wells are shown to be necessary, they will be added. It has been assumed for costing that the system will operate at 30 gpm. The pumping system and piping will be installed as proposed in Groundwater Alternative G3. Based on calculations of required pore volumes to remove the COCs from groundwater, it is assumed that the system will operate for 25 years.

Groundwater Treatment via Filtration and Ion Exchange. As with the groundwater influent concentrations calculated in Groundwater Alternative G3, potential influent concentrations of mercury, benzene, and arsenic for this groundwater alternative were calculated based on concentrations at nearby monitoring wells and the flow rate of the individual extraction well. The data from the 2002 groundwater sampling event were used to estimate an average concentration of mercury, benzene, and arsenic in influent groundwater. The expected mercury influent concentration is approximately 4 μg/L, expected benzene concentration is approximately 5 μg/L, and the approximate arsenic concentration is 11 μg/L. Details on the calculation are included in Table 4-6. Since the average influent concentrations exceed the POTW discharge requirements for mercury and arsenic, ex situ treatment will be required before discharge. Ion exchange was chosen for treatment of the three COCs in groundwater before discharge.

Mercury removal to low concentrations is challenging and is most commonly achieved using ion exchange. Ion exchange works by exchanging a contaminant, such as mercury, with a similarly charged ion on a solid media, or resin. In this case, mercury will be exchanged with a nontoxic ion that is released into the groundwater stream, while the mercury is retained on the ion exchange resin. There are various resins available that have high affinity for mercury. AMBERLITE® GT-73 was chosen, since it is capable of removing mercury in high salinity conditions. Mercury removal to a concentration of 4 μg/L was achieved during laboratory testing of AMBERLITE® GT-73 at starting mercury concentrations ranging from 5 to 20 mg/L. There is no demonstrated mercury removal to concentrations below 4 μg/L. Furthermore, there has been no demonstrated full-scale treatment of brackish water achieving mercury concentrations less than 4 μg/L. Since treatment is needed to 2 μg/L for discharge to the POTW, it has been assumed that bench-scale and pilot-scale testing will be required to confirm that the AMBERLITE® GT-73 can consistently remove mercury to achieve compliance with the POTW discharge limit. It is also expected that the proposed ion exchange system will treat the influent benzene and arsenic concentrations to the required GWQC effluent concentrations; however, this will be confirmed during the design phase of the project.

Figure 4-11 shows the conceptual treatment system. Influent and effluent tanks will be first used to collect water and ensure a stable supply of water to the ion exchange system. The ion exchange process is sensitive to fouling and must be protected from influent solids and influent iron and manganese. Available data show the groundwater contains up to 15 mg/L of suspended solids, 0.6 mg/L of iron, and 1.2 mg/L of manganese, which must be removed before the ion exchange system. Traditional technologies, such as pH control, GAC, and aeration, were initially evaluated for iron and manganese removal. These processes will remove iron and suspended solids, but have limited effectiveness for manganese. Greensand filters will, therefore, be used to remove iron, manganese, and the suspended solids before the ion exchange vessels. It has been assumed, for costing purposes, that the greensand filters will be continuously regenerated by a constant addition of potassium permanganate to the influent. Since the ion exchange resin can be degraded by exposure to an oxidant, granular activated carbon is then provided to destroy any residual permanganate. Included, if necessary, is pH adjustment (addition of sodium hydroxide) at the influent tank to increase the effectiveness of the greensand filters. Costs have not been included for the addition of sodium hydroxide for pH adjustment, but may be necessary after determining influent pH of the system. Table 4-8 provides the major equipment sizing for this treatment system. Costs for implementing ion exchange treatment of groundwater are estimated based on the assumptions for treatment system size and capacity shown in Table 4-9, but may be changed during the predesign studies or remedial design.

Typically, ion exchange media are regenerated at some point to remove the exchanged contaminants and allow extended use of the media. With mercury removed on AMBERLITE® GT-73, the mercury is bound so tightly to the exchange media that it is not feasible to cost-effectively regenerate the media, and it is typically replaced and disposed of when the exchange sites have been used. Initial calculations indicate that the resin will be replaced every 3 years. It has also been assumed that the spent resin would be disposed of as nonhazardous waste because of high affinity of the resin for mercury, the large volume of water that will be passed through the ion exchange vessels, and the low concentrations of influent mercury from the system.

Discharge to POTW. After treatment, the groundwater will be discharged to the POTW as presented in Groundwater Alternative G3.

Cost Estimate Assumptions

The following are the assumptions used for cost estimating purposes as part of the FS, and may be changed during predesign studies or the remedial design:

- The average concentrations of mercury, benzene, and arsenic in influent groundwater will be approximately 4 μg/L, 5 μg/L, and 11 μg/L, respectively.
- It has been assumed the system will have to operate for 25 years to achieve RAOs.

- Bench-scale and pilot-scale testing of ion exchange will be completed to verify the effectiveness of this technology to remove mercury, benzene, and arsenic from groundwater.
- It has been assumed that the ion exchange resin will be changed once every 3 years, based on technical specifications of the AMBERLITE® GT-73 (see equilibrium capacities of AMBERLITE® GT-73 in Appendix D).
- It has been assumed that the greensand filter will need to be backwashed once per week.
- It has been assumed that the elevated salt levels in groundwater will not inhibit removal of mercury, benzene, and arsenic via ion exchange after treatment with filtration.
- The treatment system will be housed in a newly constructed building adjacent to the Wolf Warehouse. This location provides adequate access to power and discharge locations.

Groundwater Media Alternative 5—Vertical Hydraulic Barrier. The objective of Groundwater Alternative 5 (G5) is to contain the areas of highest mercury concentrations within an impermeable physical barrier to protect Berry's Creek. This alternative involves the installation of a vertical hydraulic barrier around the area of highest mercury concentrations in groundwater, which are near the Wolf Warehouse.

This alternative meets the RAOs by eliminating potential migration pathways to receptors. The main remedial components of G5 are:

- Groundwater use restrictions
- Groundwater monitoring
- Containment with vertical hydraulic barrier

Groundwater Use Restrictions. Groundwater use restrictions will be implemented as described in Groundwater Alternative G2.

Groundwater Monitoring. Groundwater quality upgradient, within, and downgradient of the plume extent will be monitored as described in Groundwater Alternative G2.

Containment with Vertical Hydraulic Barrier. A vertical hydraulic barrier system, to serve as a physical barrier to groundwater flow, will be installed as depicted in Figure 4-12 to encapsulate the areas of highest mercury concentrations (around the encapsulated mercury under the Wolf Warehouse). For cost estimating purposes, a bentonite slurry method was assumed for three sides of the containment area, with a sealed sheeting system assumed for the side parallel to the railroad tracks; however, the installation method may change during predesign studies. For example, a bioslurry may be used, as the application of a bentonite slurry may not apply under conditions of high mercury concentrations. The vertical hydraulic barrier system will be keyed 2 feet into the confining layer underlying the site at a depth of approximately 20 feet. The approximate length of the slurry wall is 1,310 linear feet. Assuming an average 2-foot width of the excavation trench, approximately 312 cubic yards of hazardous soil from the upper 4.5 feet of the slurry wall alignment will be generated through the installation of the slurry wall portion.

The vertical hydraulic barrier will be designed taking the surrounding environment into consideration. The precise location of the vertical hydraulic barrier will be determined during the design phase and may have minor modifications to the alignment shown in Figure 4-12 to account for subsurface features (e.g., utilities, the Wolf Warehouse cutoff wall), surface features (e.g., the railroad spur to the south of the Wolf Warehouse, overhead power lines), and remedial actions required for the selected Soil Media Alternative. The land use of the adjacent areas and the long-term use of the area above the vertical hydraulic barrier will need to be considered. Soil generated during the installation of the slurry wall will be managed as discussed in Soil Alternatives S3 through S7. The slurry wall area will be "capped" with approximately 6 to 8 inches of compacted gravel and a restored asphalt cap. The existing asphalt parking area and the flooring of the Wolf Warehouse, with any necessary upgrades and maintenance, will limit the amount of infiltration into the area encompassed by the vertical hydraulic barrier, and effectively serve as a cap over the area.

Once constructed, the vertical hydraulic barrier would effectively isolate contaminants from the remainder of the shallow water bearing zone, while the basal clay would prevent downward contaminant migration. The asphalt cap would prevent infiltration of precipitation, and water levels within the vertical hydraulic barrier complex would stagnate, since no groundwater would enter the barrier complex from the top or sides. Tidal influences in the area, which are minimal, would not cause water table fluctuations inside the barrier complex. Given its impermeable nature, size, and position, however, the vertical hydraulic barrier system could influence local hydraulic gradients and groundwater flow in the area surrounding the barrier wall, and would need to be evaluated during predesign studies. For cost estimating purposes, hydraulic controls within the vertical hydraulic barrier and potential implementation of engineering controls around the barrier were not considered; the costs will be modified, should the need arise, after the predesign studies.

Groundwater Media Alternative 6—Vertical Hydraulic Barrier Around Site Perimeter. The objective of Groundwater Alternative 6 (G6) is to surround the entire site (developed and undeveloped areas) with a low permeability hydraulic barrier to protect Berry's Creek and contain mercury concentrations within the site limits. This alternative involves the installation of a vertical hydraulic barrier (slurry wall or sealed sheeting containment system) around the site perimeter.

This alternative meets the RAOs by eliminating potential migration pathways to receptors. The main remedial components of G6 are:

- Groundwater use restrictions
- Groundwater monitoring
- Containment with vertical hydraulic barrier
- Hydraulic controls via pumping

Groundwater Use Restrictions. Groundwater use restrictions will be implemented as described in Groundwater Alternative G2.

Groundwater Monitoring. Groundwater quality upgradient, within, and downgradient of the plume extent will be monitored as described in Groundwater Alternative G2.

Containment with Vertical Hydraulic Barrier. A vertical barrier system, to serve as a hydraulic barrier to groundwater flow, will be installed as depicted in Figure 4-13. For cost estimating purposes, a bentonite slurry method was assumed for the footage without surface obstructions (i.e., the railroad spur to the south of the U.S. Life and Wolf warehouses) and a sealed sheeting wall was assumed for the footage near the railroad spur; however, the installation method may change during predesign studies. The vertical hydraulic barrier will be keyed 2 feet into the confining layer underlying the site at a depth of approximately 20 feet. The approximate length of the vertical hydraulic barrier is 5,415 linear feet, with 4,770 linear feet consisting of a slurry installation and 645 linear feet consisting of a sealed sheeting system.

The vertical hydraulic barrier will be designed taking the surrounding environment into consideration. The land use of the adjacent areas and the long-term use of the area above the vertical hydraulic barrier will need to be considered. Soil generated during the installation of the vertical hydraulic barrier will be managed as discussed in Soil Alternatives S3, S4, S5, S6, and S7. The slurry wall area will be "capped" with approximately 1 foot of clean certified fill material, and appropriate erosion controls will be installed to stabilize the fill in an effort to minimize erosion and promote natural vegetative growth. The existing asphalt parking areas and the flooring of the existing buildings, with any necessary upgrades and maintenance, will limit the amount of infiltration into the area encompassed by the vertical hydraulic barrier, and effectively serve as a cap over the area.

Given its impermeable nature, size, and position, the vertical hydraulic barrier could influence local hydraulic gradients and groundwater flow in the area surrounding the barrier. This matter will need to be evaluated during predesign studies. For cost estimating purposes, potential implementation of engineering controls around the vertical hydraulic barrier were not considered; the costs will be modified, should the need arise, after the predesign studies.

Hydraulic Controls via Pumping. Because the vertical hydraulic barrier will surround the entire site perimeter, hydraulic controls will be necessary to remove the average volume of site infiltration in order to minimize mounding of groundwater within the barrier system. The hydraulic controls will be implemented as described in Groundwater Alternative G3 except that 7 extraction wells will be required, which will be spaced at an interval of approximately 1000 feet. It has been assumed that 5 inches of infiltration will be removed on an annual basis over the approximate 26 acres of the site. A hydraulic investigation would be conducted during the design phase to identify the actual number of extraction wells necessary, their spacing/location, and the average annual volume of groundwater required for removal to maintain hydraulic conditions within the barrier system. Groundwater removed as part of this alternative in order to maintain hydraulic levels within the barrier system will require treatment prior to offsite discharge, as discussed below.

Treatment via Filtration. A treatment system will be implemented as described in Groundwater Alternative G3. The average annual volume of groundwater collected and treated will, however, be less than that of Alternative G3 because the vertical hydraulic barrier will limit horizontal migration of groundwater into the footprint of the vertical hydraulic barrier.

Cost Estimate Assumptions

The following are the assumptions used for cost estimating purposes as part of the FS, and may be changed during predesign studies or the remedial design:

- Hydraulic controls within the vertical hydraulic containment system will consist of 7 extraction wells at a spacing of approximately 1000 feet.
- On average, 5 inches of infiltration will occur through the cap over an area of approximately 26 acres (developed and undeveloped areas). This infiltration volume will be removed via the 7 extraction wells, which will operate, on average, 10 percent of the time.
- Since the levels of mercury, benzene, and arsenic are low in groundwater, it has been assumed that GAC changeout will only occur once every 2 years.
- The treatment system will be housed in a newly constructed building adjacent to the Wolf Warehouse. This location provides adequate access to power and discharge locations.

5 Detailed Analysis of Alternatives

5.1 Introduction

The detailed analysis of alternatives presents the evaluation of remedial alternatives for soil and groundwater considered for the site relative to each other and against the NCP evaluation criteria. The detailed analysis of alternatives follows the development of alternatives, and precedes the selection of a final remedy. The extent to which alternatives are fully evaluated during the detailed analysis is influenced by the available data and the number and types of alternatives being analyzed.

The detailed analysis of alternatives consists of the following components:

- A detailed evaluation of each alternative against seven of the nine NCP evaluation criteria (two criteria are evaluated after public comment)
- A comparative evaluation

The detailed evaluation is presented in table format. The comparative evaluation is presented in text and highlights the most important factors that distinguish alternatives from each other.

5.2 Evaluation Criteria

In accordance with the NCP, remedial actions must:

- Be protective of human health and the environment
- Attain ARARs or provide grounds for invoking a waiver of ARARs that cannot be achieved
- Be cost-effective
- Use permanent solutions and alternative treatment technologies or resource-recovery technologies to the maximum extent practicable
- Satisfy the preference for treatment that reduces TMV as a principal element

In addition, the NCP emphasizes long-term effectiveness and related considerations, including:

- The long-term uncertainties associated with land disposal
- The goals, objectives, and requirements of the Solid Waste Disposal Act
- The persistence, toxicity, and mobility of hazardous substances and their constituents, and their propensity to bio-accumulate
- The short- and long-term potential for adverse health effects from human exposure

- Long-term maintenance costs
- The potential for future remedial action costs if the selected remedial action fails
- The potential threat to human health and the environment associated with excavation, transportation, disposal, or containment

Provisions of the NCP require that each alternative be evaluated against nine criteria listed in 40 CFR 300.430(e)(9). These criteria were published in the March 8, 1990, *Federal Register* (55 FR 8666) to provide grounds for comparison of the relative performance of the alternatives and to identify their advantages and disadvantages. This approach is intended to provide sufficient information to adequately compare the alternatives and to select the most appropriate alternative for implementation at the site as a remedial action. The nine evaluation criteria are:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- Community acceptance
- State acceptance.

The criteria are divided into three groups: threshold, balancing, and modifying criteria. The two threshold criteria are overall protection of human health and the environment, and compliance with ARARs. If ARARs cannot be met, a waiver may be obtained in situations where one of the six exceptions listed in the NCP occurs (see 40 CFR 300.430 (f)(1)(ii)(C) (1 to 6). Threshold criteria must be met by a particular alternative for it to be eligible for selection as a remedial action. There is little flexibility in meeting the threshold criteria—either they are met by a particular alternative, or that alternative is not considered acceptable.

The five balancing criteria weigh the trade-offs between alternatives. A low rating on one balancing criterion can be compensated by a high rating on another. The five balancing criteria include: (1) long-term effectiveness and permanence, (2) reduction of TMV through treatment, (3) short-term effectiveness, (4) implementability, and (5) cost.

The modifying criteria are community and state acceptance. These are evaluated after the feasibility study process following public comment, and are used to modify the selection of the recommended alternative. The other seven evaluation criteria (i.e., the threshold and balancing criteria) evaluated in this document are briefly described below.

5.2.1 Threshold Criteria

To be eligible for selection, an alternative must meet the two threshold criteria described below, or in the case of ARARs, must justify a waiver that is appropriate.

5.2.1.1 Overall Protection of Human Health and the Environment

Protectiveness of human health and the environment is the primary requirement that remedial actions must meet under CERCLA. A remedy is protective if it adequately eliminates, reduces, or controls all current and potential risks posed by the site through each exposure pathway. The assessment against this criterion describes how the alternative achieves and maintains protection of human health and the environment.

5.2.1.2 Compliance with ARARs

Compliance with ARARs is one of the statutory requirements of remedy selection. ARARs are cleanup standards, standards of control, and other substantive environmental statutes or regulations which are either "applicable" or "relevant and appropriate" to the CERCLA cleanup action (42 USC 9621[d][2]). Applicable requirements address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site. Relevant and appropriate requirements are those that, while not applicable, address problems or situations sufficiently similar to those encountered at the CERCLA site such that their use is well suited to environmental or technical factors at a particular site. The assessment against this criterion describes how the alternative complies with ARARs or presents the rationale for waiving an ARAR. As defined in Section 2, ARARs are grouped into three categories: (1) chemical-specific, (2) location-specific; and (3) action-specific.

5.2.2 Balancing Criteria

The five criteria listed below are used to weigh the trade-offs between alternatives.

5.2.2.1 Long-term Effectiveness and Permanence

This criterion reflects CERCLA's emphasis on implementing remedies that will ensure protection of human health and the environment in the long term, as well as in the short term. The assessment of alternatives against this criterion evaluates the residual risks at a site after completing a remedial action or enacting a no action alternative and includes evaluation of the adequacy and reliability of controls.

5.2.2.2 Reduction of TMV through Treatment

This criterion addresses the statutory preference for remedies that employ treatment as a principal element. The assessment against this criterion evaluates the anticipated performance of the specific treatment technologies an alternative may employ. The criterion is specific to evaluating only how treatment reduces TMV, and does not address containment actions such as capping.

5.2.2.3 Short-Term Effectiveness

This criterion addresses short-term impacts of the alternatives. The assessment against this criterion examines the effectiveness of alternatives in protecting human health and the environment (i.e., minimizing any risks associated with an alternative) during the construction and implementation of a remedy until the response objectives have been met.

5.2.2.4 Implementability

The assessment against this criterion evaluates the technical and administrative feasibility of the alternative and the availability of the goods and services needed to implement it.

5.2.2.5 Cost

Cost encompasses engineering, construction, and operations and maintenance (O&M) costs incurred over the life of the project. The assessment against this criterion is based on the estimated present worth of these costs for each alternative. Present worth is a method of evaluating expenditures such as construction and O&M that occur over different lengths of time. This allows costs for remedial alternatives to be compared by discounting all costs to the year that the alternative is implemented. The present worth of a project represents the amount of money, which if invested in the initial year of the remedy and disbursed as needed, would be sufficient to cover all costs associated with the remedial action. As stated in the RI/FS guidance (USEPA, 1988a), these estimated costs are expected to provide an accuracy of plus 50 percent to minus 30 percent. Appendix C provides a breakdown of the cost estimate for each of the alternatives.

The level of detail required to analyze each alternative against these evaluation criteria depends on the nature and complexity of the site, the types of technologies and alternatives being considered, and other project-specific considerations. The analysis is conducted in sufficient detail to understand the significant aspects of each alternative and to identify the uncertainties associated with the evaluation.

The cost estimates presented below have been developed strictly for comparing the alternatives. The final costs of the project and the resulting feasibility will depend on a number of factors, such as actual labor and material costs, competitive market conditions, actual site conditions, final project scope, the implementation schedule, the firm selected for final engineering design, and other variables. Final project costs will, therefore, vary from these cost estimates. Because of these factors, project feasibility and funding needs must be reviewed carefully before specific financial decisions are made or project budgets are established to help ensure proper project evaluation and adequate funding.

The cost estimates have an intended accuracy range of +50 to -30 percent. The range applies only to the alternatives as they are defined in Section 4, and does not account for changes in the scope of the alternatives. Selection of specific technologies or processes to configure remedial alternatives is intended not to limit flexibility during remedial design, but to provide a basis for preparing cost estimates. The specific details of remedial actions and cost estimates would be refined during final design.

5.3 Detailed Analysis of Soil Media Alternatives

The analysis consists of detailed and comparative evaluations of the remedial alternatives.

5.3.1 Detailed Evaluation

The following alternatives were developed and described in Section 4 for the soil target areas:

- Soil Media Alternative 1—No Further Action
- Soil Media Alternative 2—Use Restrictions for Properties with Deed Notice Concurrence and Limited Excavation to RDCSCC
- Soil Media Alternative 3—Excavation of Undeveloped Area with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC
- Soil Media Alternative 4—Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC
- Soil Media Alternative 5—Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Excavation of Other Properties to RDCSCC, and Use Restrictions on Undeveloped and Developed Areas
- Soil Media Alternative 6—Excavation of Developed Area with ≥ 620 mg/kg Mercury, Excavation of Undeveloped Area and Other Properties to RDCSCC, and Use Restrictions on Developed Area
- Soil Media Alternative 7—Excavation of Undeveloped, Developed, and Other Properties to RDCSCC and Use Restrictions on the Railroad

These soil alternatives were evaluated in detail using the seven evaluation criteria described in Section 5.1. The detailed evaluations for these soil media alternatives are presented in Table 5-1. A comparison of remedial actions contained within each soil alternative is presented in Table 5-2.

5.3.2 Comparative Analysis

5.3.2.1 Overall Protection of Human Health and the Environment

As discussed in Section 2.2.2, the remedial action objectives for the soil target areas are:

- Prevent/minimize potential migration of contaminants in surface soil via windblown dust and surface runoff to the marsh area and Berry's Creek
- Prevent/minimize potential migration of contaminants to ground water, which may discharge to surface water and sediment
- Prevent/minimize potential migration of contaminants in onsite sediments via surface runoff to the marsh area and Berry's Creek

- Reduce human and ecological receptor's potential exposure to contaminants in surface soil to within acceptable risk levels
- Reduce exposure to contaminants in soil in the undeveloped fill area to allow for reasonable anticipated future land use

The No Further Action Soil Alternative (S1) is not protective of human health and/or the environment because it does not eliminate potential migration, either through infiltration control or airborne emission control, and does not eliminate potential direct contact exposure routes to COC-impacted soil or historic fill. Soil Alternatives S2 through S7 are all considered protective of human health and the environment, since they would: (1) eliminate potential direct contact to COC-impacted soil, (2) minimize potential migration of COCs from impacted soil, and (3) include locating and removing the drain line in the undeveloped fill area, thereby eliminating the potential migration pathway from the developed area to Berry's Creek. Furthermore, soil with concentrations that exceed ecological benchmarks do not remain available to ecological receptors after the remedial alternatives have been conducted because each alternative (except Soil Alternative S1, the No Action Alternative) includes capping with an asphalt cap or removal.

Soil Alternative S2 relies primarily on a cap (either the existing asphalt cap in the developed area or a new cap in the undeveloped fill area) to meet the RAOs. The cap will prevent migration via windblown dust and surface runoff and will also eliminate exposure to contaminants in soil. With the restrictions placed on the properties through Deed Notices with concurrence from property owners, Soil Alternative S2 is protective. Where Deed Notice(s) are not obtained, excavation to RDCSCC will be implemented. In accordance with N.J.A.C. 7:26E-6.2(c), the presumptive remedy for historic fill is capping with institutional controls. Soil Alternative S2 also protects human health and the environment by utilizing the engineering and institutional controls for historic fill in soil at the site.

Soil Alternatives S3 also relies on installation of a cap in the undeveloped fill area and enhancement of the existing asphalt cap in the developed area (as discussed in Soil Alternative S2), along with a excavation of soil exceeding 620 mg/kg in the undeveloped fill area to meet RAOs. Soil Alternative S3 is slightly more protective of human health and the environment than Soil Alternatives S1 and S2, since this alternative includes removal of mercury mass in soil as estimated to be 2,100 cubic yards. As with Soil Alternative S2, Soil Alternative S3 is also protective of human health and the environment by utilizing engineering and institutional controls to prevent exposure to historic fill at the site. Soil Alternative S3 is, however, similar to Soil Alternative S2 in achieving the first three RAOs (direct exposure and potential migration elimination) since this alternative does not include removing soil that may represent a continuing source to groundwater contamination. In 2002, mercury, arsenic, and benzene were not detected above the groundwater PRGs (the NJDEP GWQC) in monitoring wells adjacent to and downgradient from the proposed excavation area (wells MW-1, MW-2, and MW-5). Although Soil Alternative S3 is slightly more protective of human health and the environment than Alternative S2, it is no more effective than Alternative S2 for meeting the RAOs for protection of sediments in Berry's Creek through potential migration of groundwater contamination.

Soil Alternative S4 also relies on installation of a cap in the undeveloped fill area and enhancement of the existing asphalt cap in the developed area (as discussed in Soil

Alternative S2), along with a excavation of soil with mercury concentrations exceeding 620 mg/kg in both the undeveloped fill area and developed area (estimated at 7,140 cubic yards). Soil Alternative S4 is more protective of human health and the environment than the other Soil Alternatives (S1 through S3) since this alternative includes removal of mercury-impacted soil exceeding 620 mg/kg in both the developed and undeveloped fill areas. As with Soil Alternative S2 and S3, Soil Alternative S4 is also protective of human health and the environment by utilizing engineering and institutional controls to prevent exposure to historic fill at the site. Soil Alternative S4 is similar to Soil Alternatives S2 and S3 in achieving the first three RAOs (direct exposure and potential migration elimination), although Soil Alternative S4 is more protective of human health and the environment due to a greater amount of mercury mass being removed from the Site.

Soil Alternative S5 includes excavation of mercury-contaminated soil above 620 mg/kg in the developed and undeveloped areas; excavation of the Blum, Prince Packing, Lin-Mor, Borough of Wood-Ridge, and EJB properties to unrestricted use standards; and capping of the developed area to meet RAOs. As with Soil Alternatives S3 and S4, this alternative is considered more protective of human health and the environment than Soil Alternatives S1 and S2, since it includes removal of larger quantities of impacted soil from the site. Soil Alternative S5 is protective of human health and the environment by utilizing engineering and institutional controls to prevent exposure to historic fill at the site. Soil Alternative S5, however, may be more protective than Soil Alternatives S2 through S4 in ability to achieve the first three RAOs (direct exposure and potential migration elimination), because of incremental increases in removal of soil that may be a continuing source to groundwater contamination.

Soil Alternative S6 includes excavation and offsite disposal of impacted soil above the PRGs in the undeveloped area and the offsite properties to achieve unrestricted use classification, along with excavation of mercury-contaminated soil above 620 mg/kg in the developed area. Soil Alternative S6 is more protective than Soil Alternative S5 because more mercury mass is removed from the undeveloped area in addition to the achievement of the direct exposure RAO. Soil Alternative S6 is also protective of human health and the environment by utilizing engineering and institutional controls to prevent exposure to historic fill at the site.

Soil Alternative S7 is protective of human health and the environment at the site since this alternative includes complete removal and offsite disposal of impacted soil above the PRGs. It achieves the first three RAOs that eliminate direct exposure and/or migration; however, the RAO for future use is significantly hindered since this alternative calls for the shutdown of current industrial operations and demolition of currently viable warehouse buildings to implement the remedy.

5.3.2.2 Compliance with ARARs

All soil alternatives other than No Further Action, Soil Alternative S1, are expected to comply with ARARs. Soil alternatives that include restricted use through engineering and institutional controls for reasonable future use (Soil Alternatives S2, S3, S4, S5, and S6) would comply with ARARs through restrictions on deeds and long-term monitoring of the integrity of any engineering controls.

Controlling airborne emissions during implementation of the alternatives, including excavation (Soil Alternatives S2 through S7), would be required to comply with ARARs related to the Clean Air Act. All location- and action-specific ARARs would be met under all the soil alternatives.

The NJDEP ARARs for presumptive remedies for historic fill material (N.J.A.C. 7:26E-6.2(c)) are met for all of the soil alternatives; however, Soil Alternatives S2, S3, and S4 are the closest to fitting the presumptive remedies as established by the NJDEP (engineering and institutional controls).

5.3.2.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence of the soil alternatives vary, largely as a result of the adequacy and reliability of the systems implemented. Active treatment or removal alternatives, such as Soil Alternatives S3 through S7, are generally more effective in the long term over passive alternatives such as Soil Alternative S2, since residual risks remain after the remedial actions. Soil Alternative S3 and S4 would be slightly more effective than Soil Alternative S2; however, residual risks would continue with both of these alternatives since a majority of the contaminant mass would remain. When ranked for long-term effectiveness, Soil Alternative S7 is the best alternative, since all of the impacted soil is removed from the site. Alternatives S6, S5, S4, S3, and S2 follow in effectiveness, respectively, since soil is removed with Soil Alternatives S6, S5, S4, S3, and S2, and Soil Alternatives S2 through S6 include land use restrictions. Soil Alternatives S3, S4, and S5 are considered permanent in the areas where soil will be excavated. Alternatives S3 through S7 remove impacted soil for offsite disposal in incremental amounts, so these alternatives are also permanent.

5.3.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternatives S1 and S2 do not significantly reduce the volume of contaminants through treatment, although Soil Alternative S2 does remove 700 cubic yards of impacted soil from the Lin-Mor property for reuse and capping in the undeveloped fill area. Soil Alternative S3 removes and treats approximately 2,100 cubic yards of the highest mercury concentration impacted soil in the undeveloped fill area. Soil Alternative S4 removes and treats approximately 7,140 cubic yards of the highest mercury concentration impacted soil in both the developed and undeveloped fill areas. Soil Alternative S5 removes an approximate additional 6,800 cubic yards from Ethel Boulevard and the impacted areas north of the railroad for placement in the capped, undeveloped fill area, thus reducing the mobility potential of this soil. Soil Alternative S6 removes approximately 135,000 cubic yards of soil (122,500 cubic yards through excavation of the undeveloped fill area; 6,800 cubic yards through excavation of the Blum, EJB, Borough of Wood-Ridge, Lin-Mor, and Prince Packing properties; 5,050 cubic yards from the developed area; and 450 cubic yards during excavation of the West Ditch) for offsite treatment and disposal. The largest TMV reduction is achieved through Soil Alternative S7, with excavation, treatment, and offsite disposal of approximately 160,000 cubic yards of soil (157,500 cubic yards from the developed and undeveloped areas and 1,800 cubic yards from the West Ditch).

5.3.2.5 Short-Term Effectiveness

The short-term effectiveness of the soil alternatives can be broken down into: (1) protectiveness of workers and the community during implementation, and (2) the time to complete the remedial alternative, which varies, largely as a result of the adequacy and reliability of the systems implemented. Generally, soil alternatives that include excavation, offsite treatment, and disposal of mercury-impacted soil are less protective of workers and the community than soil alternatives that do not disturb the soil. Soil Alternative S2 is the most protective of workers and the community during implementation; however, alternatives that involve removal of impacted soil will generally meet RAOs sooner than soil alternatives that include long-term engineering and institutional controls.

When considering protection of workers and the community during implementation, there are minimal impacts during remedial construction of Soil Alternative S2, since this alternative does not involve workers contacting impacted soil for an extended period and does not generate windborne air emissions through extensive soil excavation. Soil Alternatives S3, S4, S5, S6, and S7 (stated in increasing order of potential impacts) have the potential for adverse impacts to both workers and the community during construction related to fugitive dust emissions and truck traffic hauling impacted soil. The elevated concentrations of mercury that are targeted in these excavation alternatives would require extensive health and safety requirements to ensure worker protection. Air monitoring would also be required for all of the excavation soil alternatives to protect not only workers, but also the local community (i.e., residential homes, which are within 0.25 mile of the site to the north).

Increased truck traffic on two-lane roads through these residential areas would also impact the local community. Soil Alternatives S5 through S7 would require the closure of and/or restriction of traffic on Ethel Boulevard for a period of several months, including restrictions to the industrial businesses located at 1 and 3 Ethel Boulevard. An excess of 10,000 truck visits would be required over a 2-year period (assuming 5,000 truck visits to haul contaminated material offsite and an additional 5,000 truck visits to transport clean fill to the site) when implementing Soil Alternative S6. The number of truck visits would increase to over 26,000 (13,000 for offsite hauling and another 13,500 for clean fill transport) over nearly a 2.5-year period when implementing Soil Alternative S7. Noise and truck emissions from this extensive traffic would cause impacts to the local community. Extensive soil erosion and sediment control measures would also be required for the soil alternatives involving excavation, which would be less protective of the environment during remedial construction. Problems with the temporary surface water runoff could cause damage to Berry's Creek or adjacent wetlands during excavation actions that would not be at risk when implementing Soil Alternative S2.

When comparing the soil alternatives related to the time to complete remedial actions, the more passive alternatives can be completed sooner than the large-scale excavation alternatives. Soil Alternatives S2, S3, and S4 would take the shortest time to implement, at 4 to 6 months. Soil Alternative S5 would take nearly 8 months to complete, Soil Alternative S6 would take nearly 2.5 years to complete, and Soil Alternative S7 would take over 3 years to complete.

5.3.2.6 Implementability

Because of the elevated concentrations of mercury in soil, any soil alternative involving excavation would be more difficult to implement than utilizing engineering and institutional controls. Because of these high concentrations of mercury, additional health and safety measures must be implemented during excavation. Additionally, treatment and disposal of excavated soil must be managed as a hazardous waste, which requires additional health and safety considerations, treatment permit requirements, and shipping considerations. Soil Alternative S2 is the easiest to implement (excluding Soil Alternative S1) at the site.

After Soil Alternative S2, Soil Alternative S3 is the easiest to implement since the area of excavation is relatively small (approximately 2,100 cubic yards in undeveloped fill area and 700 cubic yards from the Lin-Mor property) and not within an area that is currently developed. Soil Alternative S4 is somewhat more difficult to implement because the volume of soil to be excavated increases to approximately 7,140 cubic yards, and some of the excavation areas are in the developed area. Soil Alternative S5 requires the additional excavation and transfer of impacted soil above the RDCSCC from the EJB, Blum, Prince Packing, and Borough of Wood-Ridge properties to the undeveloped fill area. The implementation of Soil Alternative S6 is difficult because of the volume of soil that must be handled, staged, and trucked offsite for disposal (over 100,000 cubic yards). A typical disposal facility can only handle approximately 2,000 tons per week of hazardous soil. Based on this treatment schedule, treatment would take nearly 2 years to complete. Effective management of runoff during the undeveloped fill area excavation could also be challenging. Management of runoff would need to adequately prevent contaminant migration to Berry's Creek, the Diamond Shamrock/Henkel (north) Ditch, or the OU2 marsh area south of the undeveloped fill area.

For a number of reasons, Soil Alternative S7 is the most difficult to implement. First, the proposed excavation area includes four active, operating industrial facilities (U.S. Life Warehouse, Wolf Warehouse, the Blum Property, and the Prince Packing property), and Ethel Boulevard (an active street). Implementation of this alternative would require the demolition of active warehouse facilities, including removal of the foundations of each building. Second, the volume of soil to be generated (approximately 160,000 cubic yards) would be difficult to manage because of access limitation for trucks to the site (down Park Place East, a two-lane road) that passes through a residential community. Assuming treatment of 2,000 tons per week of hazardous soil, Soil Alternative S7 would take more than 2 years to complete. This also does not take into consideration the management of debris from each of the industrial facilities that would need to be removed.

5.3.2.7 Cost

An overview of the cost analysis performed for this FS and the detailed breakdowns for each of the soil alternatives are presented in Appendix C.

The no further action soil alternative has the least present worth cost. The only cost associated with this alternative is for the 5-year annual review, resulting in a present worth of $36,000.

The lowest cost soil alternative, excluding the no action alternative, is Soil Alternative S2, which includes the installation of a new cap over the undeveloped fill area and upgrades of the existing cap in the developed area. The present worth cost for Soil Alternative S2 is $6,130,000.

Soil Alternative S3 is the next highest cost soil alternative at $8,450,000, then Soil Alternative S4 is the next highest cost at $14,090,000, followed by Soil Alternative S5 at $14,670,000, Soil Alternative S6 at $112,750,000, and Soil Alternative S7 at $135,300,000. Soil Alternative S2 is slightly less protective of human health than Soil Alternatives S3, S4, and S5, but has a much lower cost difference because of the volume of soil to be generated and the relatively high costs for treating and disposing soil that is characteristically hazardous for mercury. The soil alternative with the highest cost is Soil Alternative S7 at $135,300,000. The increasing costs of Soil Alternatives S3, S4, S5, S6, and S7 are driven by the additional volumes of soil that would require treatment as a hazardous waste.

Costs for facility reconstruction of the U.S. Life and Wolf Warehouses, all of which are both currently operating, have not been included in the present worth evaluation of Soil Alternative S7, since these costs are not related to implementation of the remedial actions. Costs for reconstruction of each industrial facility are, however, included as separate line items in Soil Alternative S7 in Appendix C since these are actual costs that would be incurred if this alternative were implemented. These costs are estimated at approximately $14,000,000.

5.4 Detailed Analysis of Groundwater Media Alternatives

5.4.1 Detailed Evaluation

The following alternatives for groundwater were developed and described in Section 4:

- Groundwater Alternative 1—No Further Action
- Groundwater Alternative 2—Natural Attenuation and Institutional Controls
- Groundwater Alternative 3—Hydraulic Controls via Pumping
- Groundwater Alternative 4—Groundwater Pump and Treat
- Groundwater Alternative 5—Vertical Hydraulic Barrier
- Groundwater Alternative 6—Vertical Hydraulic Barrier Around Site Perimeter

These groundwater alternatives were evaluated in detail using the seven evaluation criteria described in Section 5.1. Of note, after the detailed evaluation of the groundwater alternatives, the last four alternatives (G3, G4, G5, and G6) may not meet the two threshold criteria. Specifically, the environment may not be protected by implementing Groundwater Alternatives G3, G4, G5, or G6 (endangerment of adjacent wetlands) and the location-specific ARAR for protection of wetlands may not be met. These groundwater alternatives were, however, evaluated in detail, including costs, within the following section. The detailed evaluations for these groundwater media alternatives are presented in Table 5-3. A comparison of the remedial actions contained within each groundwater media alternative is presented in Table 5-4.

5.4.2 Comparative Analysis

5.4.2.1 Overall Protection of Human Health and the Environment

As discussed in Section 2.2.2., the groundwater remedial action objectives are:

- Prevent/minimize the potential downgradient and offsite migration of contaminated groundwater to the marsh area and Berry's Creek
- Reduce human and ecological receptor's potential exposure to contaminants in groundwater to within acceptable risk levels

The no further action alternative (Groundwater Alternative G1) is not considered protective of human health and the environment because it does not include groundwater monitoring or required institutional controls to prevent access and monitor potential migration of contaminated groundwater. Future exposure to groundwater would result in unacceptable risks. The remaining groundwater alternatives are considered protective since the CEA will restrict use of impacted groundwater through the life of the remedial action.

Groundwater Alternative G2 is considered protective of human health and the environment, since the CEA restricts groundwater use within the impacted area and monitors any potential migration of COCs in groundwater. Based on the groundwater data collected in 2002, mercury, arsenic, and benzene have not migrated offsite and are not impacting the Diamond Shamrock/Henkel (north) Ditch or Berry's Creek. The concentrations of mercury and benzene in monitoring wells adjacent to the Diamond Shamrock/Henkel (north) Ditch and Berry's Creek (MW-1, MW-3, MW-4, MW-5, MW-6, and MW-12) did not exhibit exceedances of the GWQC in 2002. Arsenic was detected slightly over the GWQC in monitoring well MW-6 in 2002, but the concentrations from the 1999 event were below the GWQC. When coupled with any of the soil alternatives presented in Section 4 (with the exception of Soil Alternative S1), the RAOs for eliminating migration of impacted groundwater to Berry's Creek are achieved utilizing Groundwater Alternative G2 through the continued monitoring of groundwater at the OU1 perimeter.

Groundwater Alternative G3 involves the collection and ex situ treatment of the downgradient portion of the groundwater plume, which also achieves the RAOs for protection of downgradient receptors and protection of human and ecological receptors. This groundwater alternative is not protective of the environment, since there is a significant risk that natural resource injury may occur during pumping. The pumping, which would be completed adjacent to Berry's Creek and the OU2 marsh south of the undeveloped fill area, would likely deprive the wetland and Berry's Creek of a primary water source. Groundwater Alternative G3 is not considered a practical groundwater alternative, since natural resource injury may occur to the environment during the implementation of the action. The risk of natural resource injury would be investigated further during predesign studies and/or pilot tests.

Groundwater Alternative G4 is the most protective of human health and achieves the RAOs in the fastest time by aggressively removing the contaminant mass, both within the plume and along the downgradient portions of the plume. As with Groundwater Alternative G3, however, pumping along the perimeter of the undeveloped fill area adjacent to Berry's Creek and the OU2 wetlands may cause a change in the groundwater gradients in the vicinity of the extraction wells. Impacts to the natural resources in the areas of the extraction pumping within Groundwater Alternative G4 would be investigated further during the design phase of the project.

Groundwater Alternative G5 is protective of human health and the environment, and would achieve the RAOs for minimizing migration to Berry's Creek and encapsulating impacted groundwater, as long as it is coupled with an active soil remedy. As stated above, based on the groundwater data collected in 2002, mercury, arsenic, and benzene are not migrating downgradient and are not impacting the Diamond Shamrock/Henkel (north) Ditch or Berry's Creek. By enclosing the groundwater area that exceeds PRGs for mercury, arsenic, and benzene, the adjacent surface water bodies are protected.

For Groundwater Alternative G6, the entire site perimeter is enclosed, even those areas where PRGs for mercury, arsenic, and benzene have not been exceeded. While this alternative contains a much greater area, it is possible that COCs will migrate from areas of higher concentrations (e.g., in the vicinity of the Wolf Warehouse) to areas of lower concentration surrounding the warehouse areas. Similar to Groundwater Alternative G4, Groundwater Alternative G6 would likely deprive the OU2 wetland and Berry's Creek of a primary water source and storage reservoir. This Groundwater Alternative must be coupled with soil alternatives involving capping (Soil Alternatives S2 through S5) to prevent infiltration into the vertical hydraulic barrier system.

5.4.2.2 Compliance with ARARs

Appendix A presents a compilation of all the state and federal chemical-specific, location-specific, and action-specific ARARs considered for the site. Groundwater Alternatives G1, G3, G4, and G6 may not be in compliance with ARARs. Since Groundwater Alternatives G3, G4, and G6 could likely impact the OU2 wetlands south of the undeveloped fill area by depriving the wetlands (especially Alternatives G4 and G6) of a primary water source, the Federal National Environmental Policy Act (NEPA) (40 CFR 6, Appendix A) ARAR for the protection of wetlands would not be compliant. The only Groundwater Alternatives that will meet all chemical-, location-, and action-specific ARARs are Groundwater Alternatives G2 and G5.

5.4.2.3 Long-Term Effectiveness and Permanence

All of the groundwater alternatives (with the exception of Groundwater Alternative G1) are effective in the long term, since groundwater use restrictions (CEA) are placed on the impacted groundwater until the concentrations of COCs in groundwater are below the PRGs. The long-term effectiveness of the groundwater collection and treatment alternatives (G3, G4, and G6) is ranked higher than the other three groundwater alternatives because these involve active reduction in mercury, arsenic, and benzene concentrations in groundwater. Groundwater Alternative G4 ranks higher than Groundwater Alternative G3 (the two pumping alternatives) in long-term effectiveness, since G4 removes a larger mass of mercury. The remaining three active groundwater alternatives (Groundwater Alternatives G2, G5, and G6) are similar in their long-term effectiveness, since these alternatives rely on long-term containment of the impacted groundwater. Because of the decreased effectiveness of pump and treat systems over time, however, Groundwater Alternatives G3 and G4 may leave residuals in groundwater that cannot be treated to concentrations below the

PRGs by these systems because of the ineffectiveness of pump and treat technologies at low concentrations.

5.4.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Groundwater Alternatives G3, G4, and G6 are the only alternatives that reduce the TMV through treatment, since they remove and treat mercury-impacted groundwater through extraction and ex situ treatment before disposal. Groundwater Alternative G2 is not effective at reducing the potential for conservative contaminants, such as mercury and arsenic, to migrate offsite. Groundwater Alternatives G1, G2, and G5 do not reduce the TMV of contamination through treatment. Conversely, residuals remaining from GAC treatment (Groundwater Alternatives G3 and G6) and after ion exchange treatment in Groundwater Alternative G4 will need to be disposed of after use.

5.4.2.5 Short-Term Effectiveness

The short-term effectiveness of the groundwater alternatives (broken down into: (1) protectiveness of workers and the community during implementation, (2) the time to complete the remedial alternative, and (3) the potential impacts to the environment during implementation) vary based on the adequacy and reliability of the alternative implemented. Generally, all of the groundwater alternatives have minimal impacts to workers during implementation.

Groundwater Alternative G2 has minimal negative impacts with respect to the protection of workers during implementation, protection of community during remedial action, and environmental impacts of remedial action. The primary short-term risks are associated with proper worker protection during the collection of groundwater samples to monitor compliance of the CEA. Groundwater Alternatives G3 and G4, the two pumping alternatives, have greater impacts to workers during construction than Groundwater Alternative G2, since these alternatives involve the installation of extraction wells for pumping and treatment. Groundwater Alternative G6 has the largest short-term risks to workers, the community, and environment, because of potential contact with impacted soil (wind blown dusts and/or impacts to surface water via stormwater incidents) during installation of the vertical hydraulic barrier and the additional safety consideration that must be followed for stabilization of excavations for slurry wall-type containment systems.

There are minimal impacts to the environment during the implementation of Groundwater Alternative G2. The other groundwater alternatives would likely have a significant negative impact to the environment during implementation. Groundwater Alternatives G3 and G4 would cause the water table to be lowered and would most likely result in a drop in water tables in Berry's Creek and the OU2 wetlands to the south of the undeveloped fill area. This potential natural resource injury limits the short-term effectiveness of these pumping alternatives in protecting the environment during the remedial action. The potential natural resource injury to the environment during the implementation of Groundwater Alternatives G3 and G4 make these impractical for implementation.

The short-term effectiveness with respect to the time until the RAOs are achieved would be the shortest for the groundwater collection and treatment alternatives (G3 and G4), since these alternatives would reduce the concentrations of mercury, arsenic, and benzene in groundwater. For Groundwater Alternative G4, it is expected that groundwater PRGs would be achieved in approximately 25 years. Groundwater Alternative G3 has a similar short-term effectiveness to the more passive technologies, since this alternative relies on groundwater flow to move downgradient within the capture area of the extraction wells.

5.4.2.6 Implementability

All of the groundwater alternatives can theoretically be implemented at the site; however, there are severe limitations to Groundwater Alternatives G3 and G4. Problems with implementation of these groundwater alternatives include limitations on treatment of low-level mercury in groundwater, technical feasibility related to potential natural resource injury caused by the action, and continuing to discharge groundwater to the POTW for extended periods. Limitations to Groundwater Alternative G5 and G6 are related to installation of the vertical hydraulic containment systems adjacent to operating warehouses and operating rail spurs. Only Groundwater Alternative G2 can be easily implemented at the site in a technically feasible manner with any level of assurance.

Groundwater Alternative G3 has assumed that only GAC treatment would be required before discharge to the POTW. If the actual mercury concentrations are higher than those estimated using modeling, however, this treatment process may not be viable. Groundwater Alternatives G3 and G4 are also not technically feasible because of the potential natural resource injury that may occur by depriving the wetlands and Berry’s Creek of water.

Groundwater Alternatives G5 and G6 are technically difficult to implement because of the existing Wolf Warehouse and asphalt paving, which could make installation of a vertical hydraulic barrier surrounding the Wolf Warehouse and the adjacent rail lines and roadways difficult.

Groundwater Alternative G4 has similar limitations as G3, in that it is not technically feasible because of the potential natural resource injury that would likely occur by depriving the wetlands and Berry’s Creek of water. There are also limitations and uncertainties regarding the effectiveness of mercury treatment in saline groundwater using ion exchange. A detailed evaluation of potential treatment technologies for mercury in groundwater demonstrated that there are only a few technologies (as screened in Section 3) that would effectively treat mercury in groundwater. The leading technology, ion exchange, has proven effective in treating mercury at concentrations higher than expected at the site, but has not been demonstrated with lower concentrations. Attached in Appendix D is the specification sheet for AMBERLITE® GT-73, the readily-available resin for treatment of mercury in groundwater proposed for Groundwater Alternative G4. This resin can treat from approximately 5 to 20 mg/L to 4 μg/L, but has not been demonstrated as effective for concentrations less than 4 μg/L. Site-specific bench- and field-scale testing would be necessary before implementation to determine the actual effectiveness of AMBERLITE® GT-73 for the low levels of mercury seen in the influent. Also, when treatment options were evaluated for mercury-impacted groundwater, no field-implemented and proven systems were found to exist that could treat mercury at concentrations expected to be encountered during pumping in Groundwater Alternative G4.

5.4.2.7 Cost

A summary of the estimated costs for each of the groundwater alternatives is presented in Appendix C. The table breaks down the estimated capital, O&M, and present net worth cost.

The no further action alternative has the least present worth cost. The only cost associated with this groundwater alternative is for the 5-year annual reviews (assumed for 50 years), resulting in a present worth of $36,000. Groundwater Alternative G2 has the next lowest present worth cost at $520,000. Groundwater Alternative G5 is the next most costly groundwater alternative with a present worth at $1,860,000. After Groundwater Alternative G5, the next most costly alternative is Groundwater Alternative G3 at $3,670,000; then Groundwater Alternative G6 at $6,690,000; followed by the most costly of the alternatives, Groundwater Alternative G4 at $10,950,000. The majority of the costs associated with the three pumping alternatives are the extensive O&M costs, purchase of ion exchange resin every 3 years (G4), the need for continuous backwashing of the greensand filters, and the difficulty of treatment of mercury to the low levels needed to discharge to the POTW.

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Tables

Figures

Appendix A
ARARs

Appendix B

Summary of Residential and Non-Residential Criteria Exceedances

Appendix C
Detailed Cost Tables

Soil Media Alternatives Costs

Groundwater Media Alternatives Costs

Appendix D
Ion Exchange Vendor Information

Appendix E

Acceptance Letters of Deed Notices by Property Owners

Tables

TABLE 1-1
Current Property Ownership for OU1

Borough	Block	Lot	Owner
Wood-Ridge	332	2	Norfolk Southern
Wood-Ridge	229.01	11	EJB Holding Company and Associates
Wood-Ridge	229	1	Julius Blum and Company
Wood-Ridge	229	2	Prince Packing Products
Wood-Ridge	229	10.01	Jerbil, Inc.
Wood-Ridge	229	10.02	Jonathan and Roni Blonde
Wood-Ridge	229	8	LePetomane III, Inc. Custodial Trust
Wood-Ridge	229	4.01	Borough of Wood-Ridge
Wood-Ridge	229	4.02	Lin-Mor Corporation
Carlstadt	84	5	LePetomane III, Inc. Custodial Trust

TABLE 1-2
Average Concentrations of Compounds in Soil

Compound	Average Concentration in Surface Soils* (mg/kg)	Average Concentration in Subsurface Soils (mg/kg)	Average Concentrations Any Depth (mg/kg)*	Historic Fill Average Concentrations ** (mg/kg)	Historic Fill Maximum Concentrations ** (mg/kg)	Background Concentrations*** (mg/kg)
Benzo(a)anthracene	1	**2.7**	**2**	1.37	160	NA
Benzo(a)pyrene	1	**2.5**	**2**	1.89	120	NA
Benzo(b)fluoranthene	**2**	**3**	**2**	1.91	110	NA
Benzo(k)fluoranthene	0.7	0.9	0.77	1.79	93	NA
Dibenz(a,h)anthracene	0.2	0.18	0.211	1.24	25	NA
Indeno(1,2,3-cd)pyrene	0.6	1.1	0.735	1.41	67	NA
Zinc	**4,607**	**2,054**	**3,780**	575	10,900	162
Beryllium	0.62	**3.1**	**2.04**	1.23	80	1.07
Lead	**959**	**2,094**	**1,525**	574	10,700	177.7
Arsenic	**21.20**	**16**	**18.6**	13.15	1,098	8.26

Notes:
Bold Concentration exceed the Average Historic Fill Concentrations
*- Based on sample results from all surface soil samples (designated as "onsite" and"offsite" samples in the RI).
Average concentrations were conservatively estimated using the detection limit, if not detected over that limit.
** - N.J.A.C. 7:26E, Table 4-2 (Summary of Target Contaminant Concentrations in Typical Historic Fill Material).
*** - Table 9 from *Summary of Selected Soil Constituents and Contaminants at Background Locations in New Jersey* (NJDEP, 1993)
All concentrations reported in mg/kg
NA - Not reported by the NJDEP

TABLE 1-3
Summary of COCs

Compound	Media
Mercury	Soil
Arsenic	Soil
Lead	Soil
Mercury	Groundwater
Benzene	Groundwater
Arsenic	Groundwater

TABLE 2-1
Soil PRGs

Parameter	NJDEP Soil Screening Criteria (mg/kg) Residential		Non Residential		Protection of GW		EPA Region 9 PRG (mg/kg) 1×10^{-4} or HI =1 Residential	Source	1×10^{-6} or HI =1 Residential	Source	1×10^{-4} or HI =1 Industrial	Source	1×10^{-6} or HI =1 Industrial	Source
Aluminum							76,000	nc	76,000	nc	100,000	max	100,000	max
Antimony	14		340			(h)	31	nc	31	nc	410	nc	410	nc
Arsenic	**20**	**(e)**	**20**	**(e)**		**(h)**	**22**	**nc**	**0.39**	**ca***	**160**	**ca**	**1.60**	**ca**
Barium	700		47,000	(n)		(h)	5,400	nc	5,400	nc	67,000	nc	67,000	nc
Benzene	3		13		1		7.1	nc	0.60	ca*	24	nc	1.30	ca*
Benzo(a)anthracene	0.9		4		500		62	ca	0.62	ca	210	ca	2.10	ca
Benzo(a)pyrene	0.66	(f)	0.66	(f)	100		6.2	ca	0.062	ca	21	ca	0.21	ca
Benzo(b)fluoranthene	0.9		4		50		62	ca	0.62	ca	210	ca	2.10	ca
Benzo(k)fluoranthene	0.9		4		500		620	ca	6.20	ca	2,100	ca	21	ca
Bromomethane	79		1,000	(d)	1		3.90	nc	3.90	nc	13	nc	13	nc
Cadmium	39		100			(h)	37	nc	37	nc	450	nc	450	nc
Carbazole							2,400	ca	24	ca	8,600	ca	86	ca
Chlordane - alpha							35	nc	0.11	ca	400	nc	0.38	ca
Chloroform	19	(k)	28	(k)	1		3.60	ca/nc	3.60	ca/nc	12	ca/nc	12	ca/nc
Chromium	240	(g)	20	(i)		(h)	21,000	ca	210	ca	45,000	ca	450	ca
Chrysene	9		40		500		6,200	ca	62	ca	21,000	ca	210	ca
Copper	600	(m)	600	(m)		(h)	3,100	nc	3,100	nc	41,000	nc	41,000	nc
Dibenz(a,h)anthracene	0.66	(f)	0.66	(f)	100		6.2	ca	0.062	ca	21	ca	0.21	ca
Dichloroethylene-1,2 cis	79		1,000	(d)	1		43	nc	43	nc	150	nc	150	nc
Ethylbenzene	1,000	(d)	1,000	(d)	100		890	ca	8.90	ca	2,000	ca	20	ca
Fluoranthene	2,300		10,000	(c)	100		2,300	nc	2,300	nc	22,000	nc	22,000	nc
Indeno(1,2,3-cd)pyrene	0.9		4		500		62	ca	0.62	ca	210	ca	2.10	ca
Iron							23,000	nc	23,000	nc	100,000	max	100,000	max
Lead	**400**	**(p)**	**600**	**(q)**		**(h)**	**400**	**nc**	**400**	**nc**	**750**	**nc**	**750**	**nc**
Manganese							1,800	nc	1800	nc	19,000	nc	19,000	nc
Mercury	**14**		**270**			**(h)**	**6.10**	**nc**	**6.10**	**nc**	**62**	**nc**	**62**	**nc**
Naphthalene	230		4,200		100		56	nc	56	nc	190	nc	190	nc
Nickel	250		2,400	(k,n)		(h)	1,600	nc	1,600	nc	20,000	nc	20,000	nc
Phenanthrene							2,300	nc	2,300	nc	29,000	nc	29,000	nc
Phthalate, bis(2-ethylhexyl) (DEHP)	49		210		100		1,200	nc	35	ca*	12,000	nc/ca	120	ca
Pyrene	1,700		10,000	(c)	100		2,300	nc	2,300	nc	29,000	nc	29,000	nc
Silver	110		4,100	(n)		(h)	390	nc	390	nc	5,100	nc	5100	nc
Tetrachloroethylene	4	(k)	6	(k)	1		150	ca*	1.50	ca*	340	ca*	3.40	ca*
Thallium	2	(f)	2	(f)		(h)	5.20	nc	5.20	nc	67	nc	67	nc
Toluene	1,000	(d)	1,000	(d)	500		520	sat	520	sat	520	sat	520	sat
Trichloroethylene	23		54	(k)	1		5.3	ca	0.053	ca	11	ca	0.11	ca
Vanadium	370		7,100	(n)		(h)	550	nc	550	nc	7,200	nc	7,200	nc
Vinyl chloride	2		7		10		7.9	ca	0.079	ca	75	ca	0.75	ca
Xylenes, total	410		1,000	(d)	67	(s)	270	nc	270	nc	420	sat	420	sat
Zinc	1,500	(m)	1,500	(m)		(h)	23,000	nc	23,000	nc	100,000	max	100,000	max

NOTE:
Bolded compounds are the COCs used within the FS
Units are presented in mg/kg
ca - Cancer PRG
ca* - where nc<100X ca
nc - Noncancer PRG
sat - Soil Saturation
max - Ceiling limit
PRG - Preliminary Remediation Goal
* - NJDEP Soil Cleanup Criteria are not promulgated standards
and are considered TBCs rather than ARARs

NJDEP Soil Cleanup Criteria Notes
(c) Health based criterion exceeds the 10,000 mg/kg maximum for total organic contaminant
(d) Health based criterion exceeds the 1000 mg/kg maximum for total volatile organic contaminants.
(e) Cleanup standard proposal was based on natural background.
(f) Health based criterion is lower than analytical limits; cleanup criterion based on practical quantitation level.
(g) Criterion based on the inhalation exposure pathway.
(h) The impact to ground water values for inorganic constituents will be developed based upon site specific chemical and physical parameters.
(i) Site specific determination required for SCC for the allergic contact dermatitis exposure pathway.
(k) Criteria based on inhalation exposure pathway, which yielded a more stringent criterion than the incidental ingestion exposure pathway.
(m) Criterion based on ecological (phytotoxicity) effects.
(n) Level of the human health based criterion is such that evaluation for potential environmental impacts on a site by site basis is recommended.
(p) Criterion based on the USEPA Integrated Exposure Uptake Biokinetic (IEUBK) model utilizing the default parameters.
The concentration is considered to protect 95% of target population (children) at a blood lead level of 10 ug/dl.
(q) Criteria were derived from model developed by SEGH and designed to be protective for adults in the workplace.
(s) Criterion based on new drinking water standard.

TABLE 2-2
Groundwater PRGs

Parameter	NJDEP Groundwater Quality Criteria µg/L	Source	Federal MCL ug/L	Region 9 PRG Tap Water ug/L	Source
Aluminum	200	N.J.A.C. 7:9-6		36,000	nc
Antimony	20	N.J.A.C. 7:9-6	6	15	nc
Arsenic	**8**	**N.J.A.C. 7:9-6**	**10**	**0.045**	**ca**
Barium	2,000	N.J.A.C. 7:9-6	2,000	2,600	nc
Benzene	**1.0**	**N.J.A.C. 7:9-6**	**5**	**0.34**	**ca***
Beryllium	20	N.J.A.C. 7:9-6	4	73	nc
Cadmium	4	N.J.A.C. 7:9-6	5	18	nc
Chlorobenzene	50	GWQS Interim	100	110.0	nc
Chromium	100	N.J.A.C. 7:9-6	100	110	nc
Cobalt	100	GWQS Interim		730	nc
Copper	1,000	N.J.A.C. 7:9-6	1,300	1,500	nc
Dichlorobenzene-1,3	600	N.J.A.C. 7:9-6		5.5	nc
Dichlorobenzene-1,4	75	N.J.A.C. 7:9-6	75	0.50	ca
Dichloroethane-1,1	50	GWQS Interim		810	nc
Dichloroethane-1,2	2.0	N.J.A.C. 7:9-6	5	0.12	ca*
Dichloroethene-1,2 trans	100	N.J.A.C. 7:9-6	100	120	nc
Dichloroethylene-1,2 cis	70	GWQS Interim	70	61	nc
Dichloropropane-1,2	1.0	N.J.A.C. 7:9-6	5	0.16	ca*
Iron	300	N.J.A.C. 7:9-6		11,000	nc
Manganese	50	N.J.A.C. 7:9-6		880	nc
Mercury	**2**	**N.J.A.C. 7:9-6**	**2**	**1**	**nc**
Nickel	100	N.J.A.C. 7:9-6		730	nc
Selenium	50	N.J.A.C. 7:9-6	50	180	nc
Tetrachloroethylene	1	N.J.A.C. 7:9-6	5	0.66	ca
Thallium	10	N.J.A.C. 7:9-6	2	2.4	nc
Trichloroethane-1,1,2	3	N.J.A.C. 7:9-6	5	0.20	ca
Trichloroethylene	1	N.J.A.C. 7:9-6	5	0.028	ca
Vinyl chloride	5	N.J.A.C. 7:9-6	2	0.020	ca
Xylenes, total	1,000	GWQS Interim	10,000	210	nc
Zinc	5,000	N.J.A.C. 7:9-6		11,000	nc

NOTE:
Bolded compounds are the COCs used within the FS
Units are presented in µ/L
ca - Cancer PRG
ca* - where nc<100X ca
nc - Noncancer PRG
MCL - Maximum Contaminant Level
GWQC - NJDEP Groundwater Quality Criteria
N.J.A.C. 7:9-6 - NJDEP Ground Water Quality Standards
GWQS Interim - Interim GWQC

TABLE 3-1
Technology/Process Option Evaluation—Soil

(1) General Response Action	(2) Remedial Technologies	(3) Process Options	(4) Description	(5) Technical Implementability Screening Comments	(6) Effectiveness	(7) Technical and Administrative Implementability	(8) Capital/ O&M Cost	(9) Screening Comments
No Action	No Action	None	No action	Technically implementable	None	Good	None/Low	Required for comparison by NCP; does not meet RAOs.
Monitoring	Soil Sampling	Soil sampling and subsequent laboratory analysis	Monitor the effectiveness of the chosen remedial action over the course of time or for post-excavation sampling.	Technically implementable	Not Applicable	Good	Low/Low	Does not meet RAOs when implemented alone; is potentially applicable in conjunction with other technologies.
Monitoring	Pre-Design Investigations	Collection and analysis of additional soil samples	Involves the collection of additional soil samples to further refine soil target areas and depths.	Technically implementable	Not Applicable	Good	Low/Low	Does not meet RAOs when implemented alone; is applicable in conjunction with other technologies.
Monitoring	Air Sampling	Air sampling and subsequent laboratory analysis	Monitor the concentration of gaseous or particulate mercury in ambient air.	Technically implementable	Demonstrated	Good	Low/Low	Is potentially applicable in conjunction with other technologies, such as asphalt or concrete caps.
Institutional Controls	Institutional Controls	Land Use Restrictions	Restrict access to contaminated soils through local ordinances, building permits, restrictive covenants on property deeds (Deed Notice) and state registries of contaminated sites.	Technically implementable	Fair	Fair	Low/Low	May not meet RAOs when implemented alone if applicable engineering controls are also required; may be applicable in conjunction with other technologies.
Natural Attenuation	***Sampling and Analysis***	***Soil sampling and subsequent laboratory analysis***	***Soil sampling and subsequent laboratory analysis to verify natural attenuation of COCs.***	***Not applicable for mercury and other metals in soils.***	***None***	***Low***	***Low/Low***	***No data to indicate natural attenuation of mercury ongoing in soils. Not included as part of soil remedial technologies.***
In situ Treatment	***Physical/ Chemical***	***Chemical Oxidation***	***Degrade contaminants by chemical oxidation. Typical oxidants include ozone, hydrogen peroxide, potassium permanganate, sodium permanganate and sodium persulfate.***	***Not applicable to COCs in soil***	***Low***	***Low***	***Moderate/ High***	***Not applicable for mercury and other metals (such as arsenic and lead) in soils. Potential for formation of toxic by-products and mobilization of sorbed metals.***

TABLE 3-1
Technology/Process Option Evaluation—Soil

(1) General Response Action	(2) Remedial Technologies	(3) Process Options	(4) Description	(5) Technical Implementability Screening Comments	(6) Effectiveness	(7) Technical and Administrative Implementability	(8) Capital/ O&M Cost	(9) Screening Comments
In situ Treatment	*Physical/ Chemical*	*Reduction*	*Degrade contaminants by chemical reduction. Addition of reducing agents such as zero valent iron to soils.*	*Technically implementable.*	*Low*	*Low*	*High/High*	*Not applicable for mercury in soils.*
In situ Treatment	*Physical/ Chemical*	*Stabilization*	*Immobilize contaminants by mixing in solidification agents.*	*Geologic conditions at site (high water table and fill material) makes implementation difficult.*	*Potential*	*Low*	*Moderate/ NA*	*Applicable for COCs, but geologic conditions at site (high water table and fill material) makes mixing and ensuring a homogeneous mixture difficult.*
In situ Treatment	*Physical/ Chemical*	*Soil Vapor Extraction (SVE)*	*Extract contaminants by establishing a vacuum.*	*Not applicable for mercury and other metals in soils.*	*Low*	*Low*	*Moderate/ NA*	*Not effective for most COCs.*
In situ Treatment	*Physical/ Chemical*	*Dual Phase Extraction (DPE)*	*Extraction of groundwater to remove water and expose soils to vapor extraction. Similar to SVE but includes dewatering within the same well.*	*Not applicable for mercury and other metals in soils.*	*Low*	*Low*	*Moderate/ NA*	*Not effective for most COCs.*
In situ Treatment	*Physical/ Chemical*	*Washing/ Flushing*	*Wash or flush soil with water or surfactant.*	*Not applicable for mercury and other metals in soils.*	*Low*	*Low*	*Moderate to High/ NA*	*Control of mobilized contaminants difficult due to site conditions (high water table and presence of fill material). Site data also demonstrates that mercury is not leachable, thus decreasing effectiveness of flushing.*
In situ Treatment	*Physical/ Chemical*	*Vitrification*	*Melt/solidify soil matrix using electric currents.*	*Limited applications.*	*Potential*	*Fair*	*High/NA*	*Limited commercial applications. Heating of soil may allow spreading to uncontaminated soil. Very costly technology relative to other technologies.*

TABLE 3-1
Technology/Process Option Evaluation—Soil

(1) General Response Action	(2) Remedial Technologies	(3) Process Options	(4) Description	(5) Technical Implementability Screening Comments	(6) Effectiveness	(7) Technical and Administrative Implementability	(8) Capital/ O&M Cost	(9) Screening Comments
***In situ* Treatment**	***Biological***	***Enhanced Reductive Dechlorination***	***Degrade contaminants by stimulating biological growth through addition of an organic substrate such as edible oil, or lactate. The biodegradation of the substrate liberates hydrogen which is then used as the electron donor in reductive dechlorination of contaminants.***	***Not applicable for mercury and other metals in soils.***	***Low***	***Low***	***High/High***	***Not applicable for mercury and other metals in soils. Presence of heavy metals may be toxic to microorganisms.***
***In situ* Treatment**	***Biological***	***Bioventing***	***Biologically degrade organics through stimulation of aerobic organisms by the addition of oxygen in air.***	***Not applicable for mercury and other metals in soils.***	***Low***	***Low***	***Low/Low***	***Not applicable for mercury and other metals in soils. Presence of heavy metals may be toxic to microorganisms. Non-homogeneous subsurface conditions present implementation difficulty.***
***In situ* Treatment**	***Thermal***	***Hot Air or Steam Stripping***	***Inject hot air or steam/ recover vapors (a variation of vapor extraction).***	***Low applicability for mercury and other metals in soils.***	***Potential***	***Low***	***High/NA***	***May not be applicable for mercury and other metals in soils. Debris buried in the media can cause operating difficulties. Mercury volatilization would require vapor treatment. High water table limits implementability.***
***In situ* Treatment**	***Thermal***	***Radio Frequency Stripping***	***Use network of Radio Frequency Transmitters to heat soil; collect vaporized contaminants with vapor extraction system.***	***Low applicability for mercury and other metals in soils.***	***Potential***	***Low***	***High/NA***	***May not be applicable for mercury and other metals in soils. Debris buried in the media can cause operating difficulties. Mercury volatilization would require vapor treatment. High water table limits implementability.***
Containment	Surface Controls	Grading	Reshape topography to control infiltration, runoff, and erosion.	Technically implementable	Demonstrated	Good	Low/Low	Potentially feasible only if used in conjunction with capping and other technologies to control infiltration and migration of contamination. Specifically applicable when used with capping technologies.

TABLE 3-1
Technology/Process Option Evaluation—Soil

(1) General Response Action	(2) Remedial Technologies	(3) Process Options	(4) Description	(5) Technical Implementability Screening Comments	(6) Effectiveness	(7) Technical and Administrative Implementability	(8) Capital/ O&M Cost	(9) Screening Comments
Containment	Surface Controls	Revegetation	Add topsoil, seed, fertilize, or plant to establish vegetation (to control erosion and reduce infiltration).	Technically implementable	Demonstrated	Good	Low/Low	Potentially feasible if used in areas of sensitive habitats. Does not match future land use plans as a stand alone option, specifically in areas surrounding active warehousing operations, but may be used in conjunction with other capping technologies.
Containment	***Cover***	***Soil***	***Place soil over contaminated soil.***	***Technically implementable***	***Low***	***Good***	***Moderate/ Moderate***	***A non-engineered, single-layer soil cover does not provide infiltration control or eliminate exposure routes for burrowing animals.***
Containment	Cap	Multi-layer	Includes a soil layer (thickness varies depending on application) and an impermeable geomembrane liner to control infiltration.	Technically implementable	Demonstrated	Good	High/ High	Provides infiltration control. Does not meet future use needed for undeveloped fill area, but is applicable for capping of the West Ditch.
Containment	Cap	Single-layer	Place asphalt, concrete, geosynthetic, or compacted soil over contaminated soils. May involve pre-cast channels for ditch.	Technically implementable	Demonstrated	Good	Low/High	Provides infiltration control. May also be used in conjunction with other caps. Concrete channels are applicable for capping the West Ditch, but does not restore receptors to natural conditions.
Excavation	Excavation of Shallow Soils	Backhoe/Front-end Loader	Physically remove shallow soils.	Technically implementable	Demonstrated	Good	High/NA	Can be executed to depths of about 20 feet. High water table complicates implementation, which will likely need dewatering. Groundwater and surface water controls would be required during implementation. Excavated soils may require treatment prior to disposal.
Ex Situ Treatment	Physical/ Chemical	Stabilization	Mix solidification agents, such as cement, flyash, and sulfide, to immobilize contaminants and/or decrease surface area and permeability.	Technically implementable	Demonstrated	Good	Moderate/ NA	Solidification to reduce leaching of mercury to below TCLP and LDR limits may be needed prior to landfill disposal.

TABLE 3-1
Technology/Process Option Evaluation—Soil

(1) General Response Action	(2) Remedial Technologies	(3) Process Options	(4) Description	(5) Technical Implementability Screening Comments	(6) Effectiveness	(7) Technical and Administrative Implementability	(8) Capital/ O&M Cost	(9) Screening Comments
Ex Situ Treatment	Physical/ Chemical	Soil Washing	"Scrub" soil to remove and separate the contaminated fraction. Metals tend to adhere to silt, clay, and organics, which in turn tend to adhere to sand and gravel. Soil fractions are physically separated by sieves, water sprays, and through settling dynamics.	Not technically implementable for soil with high fines content and/or low fractions of elemental mercury	Potential	Fair	High/NA	High fines content would result in high tonnage of high water content, contaminated fines/sludges, which may require additional dewatering and treatment. Overall use in U.S. for mercury-impacted soil is limited.
Ex Situ Treatment	***Physical/ Chemical***	***Vapor Extraction***	***Purge volatiles by forcing clean air through soil piles.***	***Not applicable for mercury and other metals in soils.***	***Low***	***Fair***	***Moderate/ NA***	***Not effective on inorganics; large footprint needed for treatment system.***
Ex Situ Treatment	***Biological***	***Biopiles***	***Biological degradation of COC by controlling soil moisture and soil aeration.***	***Not applicable for mercury and other metals in soils.***	***None***	***Low***	***Low***	***Not applicable for mercury and other metals in soils. Presence of heavy metals may be toxic to microorganisms.***
Ex Situ Treatment	***Thermal***	***Low-Temp Desorption***	***Desorbs contaminants/ treat off-gas***	***Technically implementable***	***Potential***	***Fair***	***High/NA***	***Not cost competitive; treatment of off gas costly. May produce toxic solid residue.***
Ex Situ Treatment	Thermal	Retorting	Use heating (typically 300 to 600 °C) and subsequent distillation techniques to extract mercury from contaminated soil. Desorbed mercury and water vapor are transported to a gas treatment system where they are condensed and the water is separated, filtered, and returned to the process.	Extensive treatability testing required, limited U.S.-based vendors	Potential	Fair	High/ NA	Both onsite and offsite systems may be used for treatment of high concentrations of mercury. However, offsite systems do not have capacity to treat large volumes of contaminated soil. Limited equipment availability and vendor experience for onsite systems. Not a proven technology for soil contaminated with mercury as the primary COC.
Ex Situ Treatment	***Thermal***	***Infrared***	***Decompose contaminants with infrared radiation.***	***Unproven technology***	***Potential***	***Poor***	***High/NA***	***Extensive treatability testing required; costs similar to incineration; unproven technology.***

TABLE 3-1
Technology/Process Option Evaluation—Soil

(1) General Response Action	(2) Remedial Technologies	(3) Process Options	(4) Description	(5) Technical Implementability Screening Comments	(6) Effectiveness	(7) Technical and Administrative Implementability	(8) Capital/ O&M Cost	(9) Screening Comments
Disposal	Offsite Disposal	Non-hazardous Waste or Hazardous Waste Landfill	Remove material for disposal in an appropriately permitted landfill.	Technically implementable	Demonstrated	Good	High/ NA	Soil below hazardous waste characterization limits can be disposed in a non-hazardous waste landfill. However, soil will be tested and soil failing TCLP limits will be subject to treatment standards prior to disposal in a hazardous waste landfill.
Disposal	***Onsite Disposal***	***Onsite Reuse***	***Reuses soil onsite after treatment (as needed).***	***Technically implementable***	***Demonstrated***	***Fair***	***High/NA***	***May be implementable for lower volumes of soils, but is costly to transport soils to treatment facility and back to site for reuse.***

Note: Italicized and bolded text with shading indicates technology or process option was screened from further consideration.

TABLE 3-2
Technology/Process Option Evaluation—Groundwater

(1) General Response Action	(2) Remedial Technology	(3) Process Options	(4) Description	(5) Technical Implementability Screening Comments	(6) Effectiveness	(7) Technical and Administrative Implementability	(8) Capital/ O&M Cost	(9) Screening Comments
No Action	No Action	None	No action	Technically implementable	None	Good	None/Low	May result in exposure of future groundwater users; does not meet RAOs; required for comparison by NCP.
Monitoring	Groundwater Sampling	Continued groundwater sampling and laboratory analysis	Continue sampling and analysis of groundwater.	Technically implementable	Not Applicable	Good	Low/Low	Potentially applicable in conjunction with other technologies.
Monitoring	Pre-Design Investigations	Groundwater collection and laboratory analysis	Collection of additional groundwater data to further refine the extent of impacts. May also involve data collection for bench-scale or pilot testing.	Technically implementable	Not Applicable	Good	Low/Low	Potentially applicable in conjunction with other technologies.
Institutional Controls	Groundwater Use Restrictions	Access restrictions to groundwater	Property in the Classification Exception Area (CEA) impacted by contaminated groundwater would require restrictions on groundwater use.	Technically implementable	Demonstrated	Good	Low/Low	Potentially applicable in conjunction with other technologies.
Natural Attenuation	Groundwater Sampling	Groundwater sampling and laboratory analysis	Use of naturally occurring physical, chemical and biological processes such as dispersion, biodegradation and retardation to reduce concentrations of contaminants.	Technically implementable	Low	Good	Low/Low	Potentially feasible for degradable COCs such as benzene. Attenuation of conservative substances, such as mercury and arsenic, would rely on non-biological processes including advection/dispersion, in situ reduction/precipitation, and/or adsorption.
Containment	Vertical Hydraulic Barrier	Slurry wall	Physical barrier limiting horizontal off-site migration	Technically implementable	Demonstrated	Good	Moderate/ Low	Barrier would be keyed into low-permeability clay unit approximately 20 feet below ground surface.
Containment	Vertical Hydraulic Barrier	Sealed Sheeting	Physical barrier limiting horizontal off-site migration	Subsurface debris may prevent installation.	Demonstrated	Fair	High/NA	Subsurface debris may require removal prior to driving sheeting components.

TABLE 3-2
Technology/Process Option Evaluation—Groundwater

(1) General Response Action	(2) Remedial Technology	(3) Process Options	(4) Description	(5) Technical Implementability Screening Comments	(6) Effectiveness	(7) Technical and Administrative Implementability	(8) Capital/ O&M Cost	(9) Screening Comments
In Situ Treatment	*Physical-Chemical*	*Air Sparging*	*Inject air into groundwater*	*Not applicable for mercury and other metals in groundwater.*	*None*	*Fair*	*Moderate/ Moderate*	*Ineffective for mercury and metals in groundwater. Non-homogeneous soils and debris may leave some zones unaffected.*
In Situ Treatment	*Physical-Chemical*	*Bioslurping*	*Combination of bioventing and free product recovery.*	*Not applicable for mercury and other metals in groundwater. Most effective for deeper (>30') groundwater tables.*	*None*	*Poor*	*Low*	*Not applicable to COCs.*
In Situ Treatment	*Physical-Chemical*	*Chemical Oxidation*	*Inject/extract oxidants to degrade contaminants. Typical oxidants include ozone, hydrogen peroxide, potassium permanganate, sodium permanganate and sodium persulfate.*	*Non-homogeneous subsurface limits implementability and effectiveness.*	*Potential*	*Fair*	*Moderate/ Low*	*Limited effectiveness for COCs.*
In Situ Treatment	*Physical-Chemical*	*Thermal Treatment*	*Increase temperature by steam injection, infrared, or other methods to volatilize contaminants.*	*Temperatures required for volatilization of mercury are not achievable in groundwater.*	*Low*	*Poor*	*High/High*	*Not implementable or effective.*
In Situ Treatment	*Physical-Chemical*	*Reduction*	*Degrade contaminants by chemical reduction. Addition of reducing agents such as zero valent iron.*	*Technically implementable.*	*Low*	*Low*	*High/High*	*High dosage requirement result in very high costs. Much more effective for localized areas of impact. Reducing conditions and higher dissolved iron concentrations migrate downgradient.*

TABLE 3-2
Technology/Process Option Evaluation—Groundwater

(1) General Response Action	(2) Remedial Technology	(3) Process Options	(4) Description	(5) Technical Implementability Screening Comments	(6) Effectiveness	(7) Technical and Administrative Implementability	(8) Capital/ O&M Cost	(9) Screening Comments
In Situ Treatment	***Physical-Chemical***	***Passive/ Reactive Treatment Wall***	***Treatment media is incorporated into a flow-through barrier. Groundwater is treated as it passes through the barrier.***	***Treatability testing required to identify effective treatment media.***	***Potential***	***Low***	***Moderate/ Low***	***Not demonstrated for site conditions – uncertain applicability. Treatability testing required.***
In Situ Treatment	***Biological***	***Enhanced Biodegradation***	***Degrade contaminants by stimulating biological growth through addition of an organic substrate such as edible oil, or lactate.***	***Heavy metals such as mercury may be toxic to microorganisms.***	***Low***	***Low***	***High/High***	***Not feasible. The large amount of substrate required to result in reducing conditions makes this an expensive technology. Heavy metal toxicity to microorganisms is a concern.***
Collection	Extraction	Pumping Wells	Install wells to extract contaminated groundwater.	Technically implementable	Demonstrated	Good	Moderate/ Low	Potentially feasible. Will likely need to be used in conjunction with ex situ treatment options prior to disposal. Natural resource injuries to adjacent wetlands may limit this alternative.
Collection	Active Hydraulic Controls	Pumping Wells	Extract groundwater to create a hydraulic barrier to offsite migration of contaminants	Technically implementable	Demonstrated	Good	Moderate/ Low	Potentially feasible. May need to be used in conjunction with ex situ treatment options prior to disposal. Natural resource injuries to adjacent wetlands may limit this alternative.
Ex Situ Treatment	***Physical-Chemical***	***Air Stripping***	***Phase separation by forced air***	***Not practical for water containing mercury.***	***Low***	***Low***	***Low/ Moderate***	***Air stripping is generally not practical for water containing mercury.***
Ex Situ Treatment	Physical-Chemical	Filtration	Removal of solids by passing water through porous media.	Not practical for overall treatment of mercury, but may be included to aid in other treatment processes.	Low/NA	Low	Low/Low	May be used in conjunction with other ex situ treatment processes to remove solids from water before treatment.

TABLE 3-2
Technology/Process Option Evaluation—Groundwater

(1) General Response Action	(2) Remedial Technology	(3) Process Options	(4) Description	(5) Technical Implementability Screening Comments	(6) Effectiveness	(7) Technical and Administrative Implementability	(8) Capital/ O&M Cost	(9) Screening Comments
Ex Situ Treatment	Physical-Chemical	Adsorption/ absorption	Treat with granular activated carbon, greensand, or other adsorptive media	Technically implementable	Potential	Low	Moderate/ Low	GAC will achieve low levels (25-30 percent) removal effectiveness for mercury. May not be applicable for higher removal rates necessary to meet discharge requirements. Greensand filtration will remove iron and manganese, which are background compounds in groundwater.
Ex Situ Treatment	Physical-Chemical	Ion Exchange	Treat with selected resins	Technically implementable	Potential	Fair	High/High	May be viable technology for mercury treatment. Specialty resins may need to be developed to treat mercury. Also, high salt, iron, and manganese content in groundwater may limit effectiveness of technology.
Ex Situ Treatment	Physical-Chemical	Nanofiltration	Remove contaminants by forcing water through high pressure membrane	Difficult operation.	Demonstrated	Good	High/High	Difficult to operate and not a proven technology for mercury in water. High O&M costs related to system operations.
Ex Situ Treatment	Physical-Chemical	Reverse Osmosis	Remove sub-micron size contaminants by forcing water through high pressure membrane	Difficult operation and maintenance. Presence of organic solvents and other contaminants can damage the membrane.	Potential	Fair	High/High	Difficult to operate and not a proven technology for mercury in water. High O&M costs related to system operations. Presence of organic solvents can damage membrane.
Ex Situ Treatment	Physical-Chemical	Precipitation/ Coagulation/ Flocculation	Remove metals by chemical precipitation or coagulation/flocculation	Technically implementable	Potential	Fair	Moderate/ Moderate	Effective for metals. Not effective for organics. Bench testing may be required to determine chemical dosages. Not as effective as other available technologies (ion exchange and nanofiltration).
Ex Situ Treatment	***Biological***	***Bioreactors***	***Degrade organic contaminants using microbes***	***Not effective for metals, heavy metals may be toxic to microorganisms.***	***Potential***	***Low***	***High/High***	***Biological treatment is not a feasible technology for heavy metals such as mercury, which may be toxic to microorganisms.***

TABLE 3-2
Technology/Process Option Evaluation—Groundwater

(1) General Response Action	(2) Remedial Technology	(3) Process Options	(4) Description	(5) Technical Implementability Screening Comments	(6) Effectiveness	(7) Technical and Administrative Implementability	(8) Capital/ O&M Cost	(9) Screening Comments
Ex Situ Treatment	***Biological***	***Constructed Wetlands***	***Degrade organic contaminants using microbes***	***Not effective for water containing mercury.***	***Low***	***Low***	***High/High***	***Constructed wetlands are generally not effective for water containing mercury.***
Discharge	Sewer	Publicly Owned Treatment Works (POTW)	Discharge treated groundwater to POTW	Technically implementable	Demonstrated	Fair to Good	Low/Low	Potentially feasible. Feasibility depends on contaminant concentrations and discharge volumes.
Discharge	***Subsurface***	***Injection Wells***	***Pump treated groundwater back into subsurface***	***Not practical for site conditions (high water table). Mounding of the water table is a concern.***	***Demonstrated***	***Fair***	***Moderate/ High***	***Not practical for site (high water table). Mounding of the water table is a concern. Injected water would easily reach nearby surface water.***
Discharge	Surface	Surface Water	Discharge treated groundwater into nearby surface water (Berry's Creek)	Technically implementable	Demonstrated	Fair	Moderate/ High	Dependant on contaminant concentrations and discharge limits. Treatment to meet ambient water quality standards for mercury would be required.

Note: Italicized and bolded text with shading indicates technology or process option was screened from further consideration.

TABLE 4-1
Technology Screening Summary – Soil Media

Remedial Technologies or Process Options	Soil Alternative S1 No Further Action	Soil Alternative S2 Use Restrictions for Properties with Deed Notice Concurrence and Limited Excavation to RDCSCC	Soil Alternative S3 Excavation of Undeveloped Area with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC	Soil Alternative S4 Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC	Soil Alternative S5 Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Excavation of Other Properties to RDCSCC, and Use Restrictions on Undeveloped and Developed Areas	Soil Alternative S6 Excavation of Developed Area with ≥ 620 mg/kg Mercury, Excavation of Undeveloped and Other Properties to RDCSCC, and Use Restrictions on Developed Area	Soil Alternative S7 Excavation of Undeveloped, Developed, and Other Properties to RDCSCC and Use Restrictions on the Railroad
Land Use Restrictions		X	X	X	X	X	X
Grading		X	X	X	X	X	X
Single-Layer Cap (New)		X	X	X	X		
Asphalt and Building Foundation Caps (Existing)		X	X	X	X	X	
Excavation (Drain Line)		X	X	X	X	X	X
Excavation (Soil)			X	X	X	X	X
Excavation (55-Foot Buffer)		X	X	X	X	X	X
Capping of the West Ditch		X	X	X	X	X	
Excavation of the West Ditch							X
Stabilization			X	X	X	X	X
Soil Reuse (55-Foot Buffer)		X	X	X	X		
Off Site Disposal		X	X	X	X	X	X

TABLE 4-2
Technology Summary – By Property

Area/Property	Lot and Block	Soil Alternative S1 No Further Action	Soil Alternative S2 Use Restrictions for Properties with Deed Notice Concurrence and Limited Excavation to RDCSCC	Soil Alternative S3 Excavation of Undeveloped Area with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC	Soil Alternative S4 Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC	Soil Alternative S5 Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Excavation of Other Properties to RDCSCC, and Use Restrictions on Undeveloped and Developed Areas	Soil Alternative S6 Excavation of Developed Area with ≥ 620 mg/kg Mercury, Excavation of Undeveloped Area and Other Properties to RDCSCC, and Use Restrictions on Developed Area	Soil Alternative S7 Excavation of Undeveloped, Developed, and Other Properties to RDCSCC and Use Restrictions on the Railroad
Undeveloped Fill Area	Block 229, Lot 8 Block 84, Lot 5	None	New Cap, Excavation of West Ditch and Geomembrane Liner, Placement of 55 foot Buffer Soil, Removal of Drain Line, Grading, Land Use Restrictions	Excavation, Treatment (If Necessary), Offsite Disposal, New Cap, Excavation of West Ditch and Geomembrane Liner, Placement of 55 foot Buffer Soil, Removal of Drain Line, Grading, Land Use Restrictions	Excavation, Treatment (If Necessary), Offsite Disposal, New Cap, Excavation of West Ditch and Geomembrane Liner, Placement of 55 foot Buffer Soil, Removal of Drain Line, Grading, Land Use Restrictions	Excavation, Treatment (If Necessary), Offsite Disposal, New Cap, Excavation of West Ditch and Geomembrane Liner, Placement of 55 foot Buffer Soil, Removal of Drain Line, Grading, Land Use Restrictions	Excavation, Excavation of West Ditch and Concrete Liner, Treatment (If Necessary), Offsite Disposal, Grading, Removal of Drain Line	Excavation, Treatment (If Necessary), Offsite Disposal, Removal of Drain Line, Grading
U.S. Life Warehouse	Block 229, Lot 10.01	None	Existing Cap, Land Use Restrictions	Existing Cap, Land Use Restrictions	Excavation, Treatment (If Necessary), Offsite Disposal, New Cap, Grading, Land Use Restrictions	Excavation, Treatment (If Necessary), Offsite Disposal, New Cap, Grading, Land Use Restrictions	Excavation, Treatment (If necessary), Offsite Disposal, New Cap, Grading, Land Use Restrictions	Excavation, Grading, Treatment (If Necessary), Offsite Disposal
Wolf Warehouse	Block 229, Lot 10.02	None	Existing Cap, Land Use Restrictions, Air Monitoring	Existing Cap, Land Use Restrictions, Air Monitoring	Excavation, Treatment (If Necessary), Offsite Disposal, New Cap, Grading, Land Use Restrictions, Air Monitoring	Excavation, Treatment (If Necessary), Offsite Disposal, New Cap, Grading, Land Use Restrictions, Air Monitoring	Excavation, Treatment (If Necessary), Offsite Disposal, New Cap, Grading, Land Use Restrictions, Air Monitoring	Excavation, Grading, Treatment (If Necessary), Offsite Disposal
Borough of Wood-Ridge (Ethel Blvd)	NA	None	Existing Cap, Land Use Restrictions	Existing Cap, Land Use Restrictions	Existing Cap, Land Use Restrictions	Excavation (to be Capped in Undeveloped Fill Area), Grading, New Cap	Excavation, Offsite Disposal, Grading, New Cap	Excavation, Offsite Disposal, Grading
Norfolk Southern	Block 332, Lot 2	None	Existing Sub-Base, Land Use Restrictions	Existing Sub-Base, Land Use Restrictions	Existing Sub-Base, Land Use Restrictions	Existing Sub-Base, Land Use Restrictions	Existing Sub-Base, Land Use Restrictions	Existing Sub-Base, Land Use Restrictions
Lin-Mor Property	Block 229, Lot 4.02	None	Excavation (to be Capped in Undeveloped Fill Area), Grading	Excavation (to be Capped in Undeveloped Fill Area), Grading	Excavation (to be Capped in Undeveloped Fill Area), Grading	Excavation (to be Capped in Undeveloped Fill Area), Grading	Excavation, Offsite Disposal, Grading	Excavation, Offsite Disposal, Grading
EJB Property	Block 229.01, Lot 11	None	New Cap, Grading, Land Use Restrictions	New Cap, Grading, Land Use Restrictions	New Cap, Grading, Land Use Restrictions	Excavation, Grading	Excavation, Grading, Offsite Disposal	Excavation, Grading, Offsite Disposal
Blum Property	Block 229, Lot 1	None	Land Use Restrictions	Land Use Restrictions	Land Use Restrictions	Excavation (to be Capped in Undeveloped Fill Area), Grading	Excavation, Grading, Offsite Disposal	Excavation, Grading, Offsite Disposal
Prince Packing Property	Block 229, Lot 2	None	Land Use Restrictions	Land Use Restrictions	Land Use Restrictions	Excavation (to be Capped in Undeveloped Fill Area), Grading	Excavation, Grading, Offsite Disposal	Excavation, Grading, Offsite Disposal

TABLE 4-3
Technology Screening Summary – Groundwater Media

Remedial Technologies or Process Options	Groundwater Alternative G1 No Further Action	Groundwater Alternative G2 Natural Attenuation and Institutional Controls	Groundwater Alternative G3 Hydraulic Controls via Pumping	Groundwater Alternative G4 Groundwater Pump and Treat	Groundwater Alternative G5 Vertical Hydraulic Barrier	Groundwater Alternative G6 Vertical Hydraulic Barrier Around Site Perimeter
Groundwater Use Restrictions		X	X	X	X	X
Groundwater Monitoring		X	X	X	X	X
Natural Attenuation		X				
Groundwater Containment (vertical hydraulic barrier)					X	X
Hydraulic Controls via Pumping			X			X
Collection via Pumping				X		
Groundwater Treatment via Filtration			X	X		X
Groundwater Treatment via Ion Exchange				X		
Groundwater Discharge to POTW			X	X		X

TABLE 4-4
Proposed Monitoring Locations

Monitoring Well	Location	Purpose
MW-10	Upgradient, northernmost corner of Site	Monitor influent concentration of constituents. Establish background groundwater concentrations.
MW-7	Adjacent to Wolf Warehouse (northeast side)	Monitor groundwater concentrations in the heart of the plume. This well has historically exhibited the highest dissolved mercury concentrations.
MW-13	Adjacent to Wolf Warehouse (southeast side)	Monitor groundwater concentrations in the heart of the plume. This well has historically exhibited the second highest dissolved mercury concentrations.
MW-6	Adjacent to Berry's Creek, north of tide gate	Monitor COC concentrations in groundwater flowing offsite into Berry's Creek.
MW-1	Adjacent to Berry's Creek, just south of tide gate	Monitor COC concentrations in groundwater flowing offsite into Berry's Creek.
MW-4	Adjacent to Berry's Creek near the north Diamond Shamrock/Henkel (north) Ditch	Monitor COC concentrations in groundwater flowing offsite into Berry's Creek.

TABLE 4-5
Flux Rates to Berry's Creek and the Diamond-Shamrock/Henkel (north) Ditch

Monitoring Well	1999 Mercury Concentration (ug/L)	Mercury Flux Rate without Cap (g/year)	Mercury Flux Rate with Cap (g/year)	1997/1999 Arsenic Concentration (ug/L)	Arsenic Flux Rate without Cap (g/year)	Arsenic Flux Rate with Cap (g/year)
MW-14	0.0499	5.98×10^{-3}	2.89×10^{-3}	17.10	2.05×10^{0}	9.92×10^{-1}
MW-6	0.0385	1.48×10^{-3}	4.63×10^{-4}	8.28	3.18×10^{-1}	9.96×10^{-2}
MW-5	0.3330	8.77×10^{-1}	6.65×10^{-2}	1.98	5.20×10^{0}	3.95×10^{-1}
MW-1	0.1270	4.49×10^{0}	3.04×10^{-1}	1.98	6.99×10^{1}	4.73×10^{0}
MW-4	0.0108	1.15×10^{0}	8.43×10^{-2}	1.98	2.10×10^{2}	1.54×10^{1}
MW-3	0.2320	3.30×10^{1}	1.53×10^{0}	1.98	2.81×10^{2}	1.30×10^{1}
MW-12	0.2160	1.54×10^{0}	1.94×10^{-1}	1.98	1.41×10^{1}	1.78×10^{0}

Note: Concentrations are from the 1999 sampling event (mercury) and the 1997/1999 sampling event averages (arsenic).

TABLE 4-6

Summary of COC Concentrations in Influent of Extraction Well Systems

Well Data		Groundwater Alternative G3 Average								Groundwater Alternative G4 Average							
Extraction Well	Nearest Monitoring Well	Pumping Rate	Percent Influent	Mercury Concentration (ug/L)	Mercury Mass Balance (ug/L)	Benzene Concentration (ug/L)	Benzene Mass Balance (ug/L)	Arsenic Concentration (ug/L)	Arsenic Mass Balance (ug/L)	Pumping Rate	Percent Influent	Mercury Concentration (ug/L)	Mercury Mass Balance (ug/L)	Benzene Concentration (ug/L)	Benzene Mass Balance (ug/L)	Arsenic Concentration (ug/L)	Arsenic Mass Balance (ug/L)
1	MW-3	5	26.32	0.07	0.0184	5.0	1.32	1.26	0.33	5	17.24	0.07	0.01	5.0	0.86	1.26	0.22
2	MW-4	5	26.32	0.02	0.0053	5.0	1.32	1.21	0.32	5	17.24	0.02	0.00	5.0	0.86	1.21	0.21
3	MW-1	5	26.32	0.02	0.0053	5.0	1.32	1.61	0.42	5	17.24	0.02	0.00	5.0	0.86	1.61	0.28
4	MW-6	2	10.53	0.069	0.0073	5.0	0.53	12.1	1.27	2	6.90	0.069	0.00	5.0	0.34	12.1	0.83
5	MW-12	2	10.53	0.035	0.0037	5.0	0.53	1.21	0.13	2	6.90	0.035	0.00	5.0	0.34	1.21	0.08
6	MW-13									5	17.24	22.91	3.95	5.0	0.86	41.50	7.16
7	MW-15									5	17.24	0.35	0.06	5.0	0.86	10.90	1.88
	Total	19			0.0399		5.00		2.47	29			4.04		5.00		10.66

Note: Concentrations are from the 2002 groundwater sampling event.

TABLE 4-7
GAC Treatment System Unit Sizing

Treatment Unit	Number	Size	Units
Equalization Tank	1	4,000	gallons
Treatment Feed Pumps	2	20	gpm
Greensand Filters diameter	2	2	feet
GAC Vessels	2	500	gallons
Clean Effluent Tank	1	4,000	gallons
Backwash pumps	2	250	gpm
Treatment building	1	30 x 30	feet

TABLE 4-8
Ion Exchange Treatment System Unit Sizing

Treatment Unit	Number	Size	Units
Equalization Tank	1	4,000	gallons
Treatment Feed Pumps	2	30	gpm
Pressure Filters (Greensand) diameter	2	4	feet
GAC Columns	4	4	feet
Ion Exchange Vessels, media volume	2	300	gallons
Total Amberlite GT-73 Media		80	Cubic Feet
Clean Effluent Tank	1	4,000	gallons
Backwash pumps	2	251	gpm
Treatment building	1	30 x 45	feet

TABLE 4-9
Ion Exchange System Operating Conditions

Parameter	Size	Units
Design Basis		
Treatment Flow Rate	30	gpm
Operating Life	25	years
Influent Mercury Concentration	0.004	mg/L
Influent Benzene Concentration	0.005	mg/L
Influent Arsenic Concentration	0.011	mg/L
Influent Iron Concentration	0.6	mg/L
Influent Manganese Concentration	1.2	mg/L
Required Effluent Mercury Concentration	0.002	mg/L
Equalization tank sizing		
Equalization time	2	hrs
Equalization tank volume	3,600	gallons
Primary filtration		
Desired filter loading	2.5	gpm/sf
Filter size	12	ft^2
Filter diameter	4	ft
Actual Filter Loading	2.4	gpm/sf
Greensand media depth	24	in
Greensand media volume (per filter)	25	CF
Greensand media volume (total)	50	CF
Anthracite media	15	inches
Anthracite Volume (Total)	31.4	CF
Backwash Expansion	40	percent
Backwash Expansion	16	in
Backwash rate	20	gpm/sf
Backwash rate	251	gpm
Backwash duration	15	minutes
Volume of BW water required	3,770	gallons
Iron Equivalent as KMnO4	1.0	(mg/L)/(mg/L)
Manganese Equivalent as KMnO4	2.0	(mg/L)/(mg/L)
Eq KMnO4 for Iron	1.3	mg/L
Eq KMnO4 for Manganese	1.2	mg/L
Total KMnO4 Equivalent of Iron and Manganese	2.5	mg/L
Treatment between regeneration	4,000	gal/CF
Volume between regeneration	100,534	gallons
Time between regeneration	3,351	minutes
Time between regeneration	2.3	days
Activated Carbon		
Number of GAC Columns	2	Each
GAC Loading	2.5	gpm/sf
Filter size	12	SF
Filter size (Diameter rounded up)	4	Feet

TABLE 4-9
Ion Exchange System Operating Conditions

Parameter	Size	Units
Area of filter	12.57	SF
GAC Media depth	30	inches
Volume of GAC (each Column)	31.4	CF
Volume of GAC (Total)	62.8	CF
Actual Filter Loading	2.4	gpm/sf
Backwash rate	10	gpm/sf
Backwash rate	126	gpm
Backwash duration	10	minute
Volume of backwash water required	1,257	gallons
Ion Exchange		
Equilibrium capacity at design Conc.	1	g Hg/L R
IX Media Loading Rate	6	BV/hr
Media Volume required per column	300	gallons
Capacity use at breakthrough	70	percent
Mercury removal capacity per column	795	g Hg
IX Media use per year	12.	CF
Volume of water treated before change-out	52,500,000	gallons
Time between change-out of media	3	years

Alternative Description: Criterion	Soil Alternative S1—No Further Action	Soil Alternative S2— Use Restrictions for Properties with Deed Notice Concurrence and Limited Excavation to RDCSCC	Soil Alternative S3—Excavation of Undeveloped Area with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC	Soil Alternative S4—Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC	Soil Alternative S5—Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Excavation of Other Properties to RDCSCC, and Use Restrictions on Undeveloped and Developed Areas	Soil Alternative S6—Excavation of Developed Area with ≥ 620 mg/kg Mercury, Excavation of Undeveloped Area and Other Properties to RDCSCC, and Use Restrictions on Developed Area	Soil Alternative S7—Excavation of Undeveloped, Developed, and Other Properties to RDCSCC and Use Restrictions on the Railroad
1. Overall protection of human health and the environment.	▪ Human exposure pathways would still exist if no actions are taken. ▪ Erosion of soils exceeding direct contact PRGs would continue. ▪ Groundwater may continue to be affected by impacted soils.	▪ Cap (both existing caps – asphalt and concrete - with upgrades and new cap in undeveloped fill area) would prevent direct contact risks; minimize leaching of contaminants, and erosion of contaminated soils. ▪ Capping of drainage ditch would prevent direct contact risks and potential migration of contamination in surface water or sediment. ▪ Institutional Controls would identify the area of soil contamination exceeding PRGs and minimize the potential for contact with contaminated soil.	▪ Cap and institutional controls in both the developed area and the undeveloped fill area would prevent direct contact risks, leaching of contaminants through infiltration of surface water, and erosion of contaminated soils. ▪ Institutional Controls would identify the area of soil contamination and minimize the potential for additional excavation of contaminated soil. ▪ Capping of drainage ditch would prevent direct contact risks and potential migration of contamination in surface water or sediment.	▪ Cap and institutional controls in both the developed area and the undeveloped fill area would prevent direct contact risks, leaching of contaminants through infiltration of surface water, and erosion of contaminated soils. ▪ Institutional Controls would identify the area of soil contamination and minimize the potential for excavation of contaminated soil. ▪ Capping of drainage ditch would prevent direct contact risks and potential migration of contamination in surface water or sediment.	▪ Cap and institutional controls in both the developed area and the undeveloped fill area would prevent direct contact risks, leaching of contaminants through infiltration of surface water and erosion of contaminated soils. ▪ Institutional Controls would identify the area of soil contamination and minimize the potential for excavation of contaminated soil. ▪ Capping of drainage ditch would prevent direct contact risks and potential migration of contamination in surface water or sediment. ▪ Excavation of soil exceeding PRGs on properties adjacent to the Site would protect human health by removing mercury, lead, and arsenic impacted soil for disposal offsite.	▪ Excavation of entire undeveloped fill area would prevent potential erosion of impacted soils to Berry's Creek. Also, removal of impacted soils in the undeveloped fill area would eliminate direct contact potential. ▪ Existing cap (with upgrades) in the developed area would prevent direct contact risks, potential leaching of contaminants (through infiltration of surface water), and possible erosion. ▪ Capping of drainage ditch with concrete would eliminate potential migration of contamination. ▪ Excavation of soil exceeding PRGs on properties adjacent to the Site and the drainage ditch would protect human health by removing mercury, lead, and arsenic impacted soil for disposal offsite.	▪ Excavation of soil exceeding PRGs would protect human health by removing mercury, lead, and arsenic impacted soils, including adjacent drainage ditch, for treatment and disposal offsite. ▪ Downgradient receptors (i.e. Berry's Creek) would be protected by the removal of impacted soils in developed and undeveloped fill areas and within the drainage ditch.
2. Compliance with ARARs	▪ Soil would continue to exceed the RDCSCC and potentially continue to cause exceedances of the GWQC if soil contamination is not treated, removed, or controlled. ▪ Monitoring of soil is not conducted so remedial time frame would remain unknown.	▪ ARARs would be met because cap integrity would be maintained through regular inspections and repairs, as necessary.	▪ ARARs would be met because cap integrity would be maintained through regular inspections and repairs, as necessary. ▪ Would comply with ARARs for disposal of a hazardous waste (as applicable) or solid waste, depending on specific characterization.	▪ ARARs would be met because cap integrity would be maintained through regular inspections and repairs, as necessary. There would also be applicable institutional controls on groundwater use. ▪ Would comply with ARARs for disposal of a hazardous waste (as applicable) or solid waste, depending on specific characterization.	▪ ARARs would be met because cap integrity would be maintained through regular inspections and repairs, as necessary. There would also be applicable institutional controls on groundwater use. ▪ Meets ARAR for achieving PRGs in soils on properties adjacent to the Site by removing soil with mercury, arsenic, and lead exceeding PRGs. ▪ Would comply with ARARs for disposal of a hazardous waste (as applicable) or solid waste, depending on specific characterization.	▪ Meets ARAR for achieving PRGs in soils in the undeveloped fill area and properties adjacent to the Site by removing soil with mercury, arsenic, and lead exceeding PRGs. ▪ Would comply with ARARs for disposal of a hazardous waste (as applicable) or solid waste, depending on specific characterization.	▪ Meets ARAR for achieving PRGs in soils by removing soil with mercury exceeding PRGs. ▪ Would comply with ARARs for disposal of a hazardous waste or solid waste (as applicable), depending on specific characterization.
3. Long-term effectiveness and permanence							

Alternative Description: Criterion	Soil Alternative S1—No Further Action	Soil Alternative S2— Use Restrictions for Properties with Deed Notice Concurrence and Limited Excavation to RDCSCC	Soil Alternative S3—Excavation of Undeveloped Area with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC	Soil Alternative S4—Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC	Soil Alternative S5—Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Excavation of Other Properties to RDCSCC, and Use Restrictions on Undeveloped and Developed Areas	Soil Alternative S6—Excavation of Developed Area with ≥ 620 mg/kg Mercury, Excavation of Undeveloped Area and Other Properties to RDCSCC, and Use Restrictions on Developed Area	Soil Alternative S7—Excavation of Undeveloped, Developed, and Other Properties to RDCSCC and Use Restrictions on the Railroad
(a) Magnitude of residual risks	▪ Risk would remain since degradation of mercury in soil is not expected. Residual risks would remain indefinitely.	▪ Long-Term residual risks would continue for contaminants left in place. Soil contamination would remain relatively unchanged indefinitely since COCs are not highly degradable. ▪ Cap will also limit infiltration to minimize residual risks that may impact groundwater.	▪ Long-Term residual risks would continue for contaminants left in place. Soil contamination would remain relatively unchanged indefinitely since COCs are not highly degradable. ▪ Cap would also limit infiltration to minimize residual risks that may impact groundwater. ▪ Excavation in the Undeveloped Area reduces the residual risk over leaving in place. However, not all long-term risks would be eliminated by implementing this alternative.	▪ Long-Term residual risks would continue for contaminants left in place. Soil contamination would remain relatively unchanged indefinitely since COCs are not highly degradable. ▪ Cap would also limit infiltration to minimize residual risks that may impact groundwater. ▪ Excavation in the developed and undeveloped areas reduces the residual risk over leaving in place. However, not all long-term risks would be eliminated by implementing this alternative.	▪ Long-Term residual risks would continue for contaminants left in place. Soil contamination would remain relatively unchanged indefinitely since COCs are not highly degradable. ▪ Cap would also limit infiltration to minimize residual risks that may impact groundwater. ▪ Excavation in the developed and undeveloped areas and properties adjacent to the Site reduces the residual risk over leaving in place. However, not all long-term risks in the undeveloped and developed area would be eliminated by implementing this alternative.	▪ Long-Term residual risks would continue for contaminants left in place in the developed area. No significant changes in concentrations would be expected for the foreseeable future in the developed area. ▪ Long-Term residual risks would be reduced by removal, treatment, and offsite disposal of soils in the undeveloped fill area and properties adjacent to the Site. However, not all long-term risks in the developed area would be eliminated by implementing this alternative.	▪ There would be no long-term residual risks under this alternative since soil with mercury over PRGs would be removed for treatment and disposal offsite.
(b) Adequacy and reliability of controls	▪ Not applicable.	▪ Cap is adequate and reliable in preventing direct contact, infiltration, and erosion of soil with concentrations exceeding PRGs. ▪ Deed restrictions are necessary to prevent intrusive activities into impacted soils and spreading of contaminated soil. They are considered adequate and reliable.	▪ Excavation of area with mercury exceeding 620 mg/kg in the undeveloped fill area is an adequate and reliable technology for mass removal, treatment, and disposal. ▪ The cap and institutional controls are adequate and reliable in preventing direct contact with impacted soils after excavation.	▪ Excavation of area with mercury exceeding 620 mg/kg in both the developed and undeveloped fill areas is an adequate and reliable technology for mass removal, treatment, and disposal. ▪ The cap and institutional controls are adequate and reliable in preventing direct contact with impacted soils after excavation.	▪ Excavation of area with mercury exceeding 620 mg/kg in both the developed and undeveloped fill areas is an adequate and reliable technology for mass removal, treatment, and disposal. ▪ Excavation and removal of soil on the properties adjacent to the Site is adequate and reliable in preventing direct contact of soil with concentrations exceeding PRGs ▪ The cap and institutional controls are adequate and reliable in preventing direct contact with impacted soils after excavation.	▪ Excavation, treatment, and disposal for the entire undeveloped fill area and soil exceeding PRGs on properties adjacent to the Site is adequate and reliable in treating impacted soils. ▪ Cap is adequate and reliable in preventing direct contact, infiltration by surface water, and erosion of soil with concentrations exceeding PRGs.	▪ Excavation, treatment, and disposal is adequate and reliable in treating impacted soils.
4. Reduction of toxicity, mobility, or volume through treatment							
(a) Treatment process used	▪ Not applicable.	▪ Not applicable	▪ Stabilization used to immobilize mercury in soil prior to offsite disposal	▪ Stabilization used to immobilize mercury in soil prior to offsite disposal	▪ Stabilization used to immobilize mercury in soil prior to offsite disposal	▪ The excavated soils would be treated prior to disposal, as necessary, to meet LDR requirements.	▪ The excavated soils would be treated prior to disposal, as necessary, to meet LDR requirements.
(b) Degree and quantity of TMV reduction	▪ Not applicable	▪ Not applicable	▪ Soil generated during excavation of the undeveloped fill area (approximately 2,100 CY) would be treated and disposed of offsite.	▪ Soil generated during excavation of the developed and undeveloped fill areas (approximately 6,400 CY) would be treated and disposed of offsite.	▪ Soil generated during excavation of the developed and undeveloped fill areas (approximately 6,400 CY) would be treated and disposed of offsite.	▪ An estimated 123,000 cubic yards of mercury contaminated soils would be treated for offsite disposal. It has been assumed that approximately 75 percent of the soil would be stabilized prior to disposal at a hazardous waste landfill and 25 percent will be disposed of at a non-hazardous waste landfill.	▪ An estimated 160,000 cubic yards of mercury contaminated soils would be treated for offsite disposal. It has been assumed that approximately 75 percent of the soil would be stabilized prior to disposal at a hazardous waste landfill and 25 percent will be disposed of at a non-hazardous waste landfill.
(c) Irreversibility of TMV reduction	▪ Not applicable	▪ Stabilization is a process where metals are immobilized in soil to minimize the leaching potential.	▪ Stabilization is a process where metals are immobilized in soil to minimize the leaching potential.	▪ Stabilization is a process where metals are immobilized in soil to minimize the leaching potential.	▪ Stabilization is a process where metals are immobilized in soil to minimize the leaching potential.	▪ Stabilization is a process where metals are immobilized in soil to minimize the leaching potential.	▪ Stabilization is a process where metals are immobilized in soil to minimize the leaching potential.
(d) Type and quantity of treatment residuals	▪ None, because no treatment included.	▪ Stabilized soil (assumed to increase by 20 percent) must still be disposed of offsite.	▪ Stabilized soil (assumed to increase by 20 percent) must still be disposed of offsite.	▪ Stabilized soil (assumed to increase by 20 percent) must still be disposed of offsite.	▪ Stabilized soil (assumed to increase by 20 percent) must still be disposed of offsite.	▪ Stabilized soil (assumed to increase by 20 percent) must still be disposed of offsite.	▪ Stabilized soil (assumed to increase by 20 percent) must still be disposed of offsite.

Alternative Description: Criterion	Soil Alternative S1—No Further Action	Soil Alternative S2— Use Restrictions for Properties with Deed Notice Concurrence and Limited Excavation to RDCSCC	Soil Alternative S3—Excavation of Undeveloped Area with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC	Soil Alternative S4—Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC	Soil Alternative S5—Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Excavation of Other Properties to RDCSCC, and Use Restrictions on Undeveloped and Developed Areas	Soil Alternative S6—Excavation of Developed Area with ≥ 620 mg/kg Mercury, Excavation of Undeveloped Area and Other Properties to RDCSCC, and Use Restrictions on Developed Area	Soil Alternative S7—Excavation of Undeveloped, Developed, and Other Properties to RDCSCC and Use Restrictions on the Railroad
(e) Statutory preference for treatment as a principal element	▪ Preference not met for soil because no treatment included.	▪ Preference not met for soil because no treatment included.	▪ Preference is met for treatment of excavated soil from the undeveloped fill area.	▪ Preference is met for treatment of excavated soil from the developed and undeveloped fill areas.	▪ Preference is met for treatment of excavated soil from the developed and undeveloped fill areas.	▪ Preference is met for the undeveloped fill area.	▪ Preference is met for soil.
5. Short-term effectiveness							
(a) Protection of workers during remedial action	▪ No remedial construction, so no risks to workers.	▪ Minimal risks to workers during cap construction, excavation within the drainage ditch and on the Lin-Mor property, and soil sampling activities assuming adherence to an adequate health and safety plan.	▪ Excavation in the undeveloped fill area and in drainage ditch could result in additional risk to workers, due to the high concentrations of mercury expected to generated. Proper health and safety procedures would be included in the Health and Safety Plan for field actions. ▪ Minimal risks to workers during cap construction after excavation is completed assuming adherence to an adequate health and safety plan.	▪ Excavation in both the developed and undeveloped fill area and in the drainage ditch could result in additional risk to workers, due to the high concentrations of mercury expected to be generated. Proper health and safety procedures would be included in the Health and Safety Plan for field actions. ▪ Minimal risks to workers during cap construction after excavation is completed assuming adherence to an adequate health and safety plan.	▪ Excavation in both the developed and undeveloped fill areas, the properties adjacent to the Site, and in the drainage ditch could result in additional risk to workers, due to the high concentrations of mercury expected to be generated. Proper health and safety procedures would be included in the Health and Safety Plan for field actions. ▪ Minimal risks to workers during cap construction after excavation is completed assuming adherence to an adequate health and safety plan.	▪ Excavation in both the developed and undeveloped fill areas, the properties adjacent to the Site, and in the drainage ditch could result in additional risk to workers, due to the high concentrations of mercury expected to be generated. Proper health and safety procedures would be included in the Health and Safety Plan for field actions. ▪ Minimal risks to workers during cap upgrades in the developed area assuming adherence to an adequate health and safety plan.	▪ Excavation could result in significant additional risk to workers, due to the high concentrations of mercury expected to be generated. Proper health and safety procedures would be included in the Health and Safety Plan for field actions.
(b) Protection of community during remedial action	▪ No remedial construction, so no short-term risks to community.	▪ Minimal risks to the community during cap construction, soil sampling, and excavation on the Lin-Mor property.	▪ Potential for air emissions and airborne particulate dispersion during excavation. Dust suppression and air monitoring would need to be performed during excavation to control potential emissions and protect the community.	▪ Potential for air emissions and airborne particulate dispersion during excavation. Dust suppression and air monitoring would need to be performed during excavation to control potential emissions and protect the community.	▪ Potential for air emissions and airborne particulate dispersion during excavation. Dust suppression and air monitoring would need to be performed during excavation to control potential emissions and protect the community.	▪ Potential for air emissions and airborne particulate dispersion during excavation of the entire undeveloped fill area. Dust suppression and air monitoring would need to be performed during excavation to control potential emissions and protect the community. ▪ There are short-term safety-related risks to community due to the number of truck loads (over 20,000 trucks that haul 18 tons per load) used to transport excavated soils and deliver clean fill. Access to the Site is through residential areas on two-lane roads.	▪ There are risks to the community during excavation, due to the close proximity of residents in the area and limited traffic access for trucks hauling impacted soils. Air monitoring and control measures would be implemented to control emissions and protect the community. ▪ There are short-term safety-related risks to community due to the number of truck loads (over 27,000 trucks that haul 18 tons per load) used to transport excavated soils and deliver clean fill. Access to the Site is through residential areas on two-lane roads.
(c) Environmental impacts of remedial action	▪ No remedial construction, so no environmental impacts from remedial action.	▪ Minimal risks to the environment during cap construction assuming implementation of adequate erosion controls. ▪ May see impacts to environment during removal of soils in 55-foot wetlands buffer and installation of geomembrane in ditch.	▪ Silt fencing would be used to eliminate soil erosion runoff during excavation to ensure no runoff of impacted soils to Berry's Creek. ▪ May see impacts to environment during removal of soils in 55-foot wetlands buffer and installation of geomembrane in ditch.	▪ Silt fencing would be used to eliminate soil erosion runoff during excavation of the developed and undeveloped fill areas to ensure no runoff of impacted soils to Berry's Creek. ▪ May see impacts to environment during removal of soils in 55-foot wetlands buffer and installation of geomembrane in ditch.	▪ Silt fencing would be used to eliminate soil erosion runoff during excavation of the developed and undeveloped fill areas to ensure no runoff of impacted soils to Berry's Creek. ▪ May see impacts to environment during removal of soils in 55-foot wetlands buffer and installation of geomembrane in ditch.	▪ Storm water re-routing would be required during and after excavation. ▪ Silt fencing would be used to eliminate soil erosion runoff during excavation to ensure no runoff of impacted soils to Berry's Creek. ▪ Would have significant impacts to the environment when lining adjacent drainage ditch with concrete.	▪ Storm water re-routing would be required during and after excavation. ▪ Silt fencing would be used to eliminate soil erosion runoff during excavation to ensure no runoff of impacted soils to Berry's Creek. ▪ Would have significant impacts to the environment when removing impacts soils in drainage ditch. May cause migration of contamination in surface water.

TABLE 5-1
Detailed Evaluation of Soil Media Alternatives

Alternative Description: Criterion	Soil Alternative S1—No Further Action	Soil Alternative S2— Use Restrictions for Properties with Deed Notice Concurrence and Limited Excavation to RDCSCC	Soil Alternative S3—Excavation of Undeveloped Area with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC	Soil Alternative S4—Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Use Restrictions for Properties with Deed Notice Concurrence, and Limited Excavation to RDCSCC	Soil Alternative S5—Excavation of Undeveloped and Developed Areas with ≥ 620 mg/kg Mercury, Excavation of Other Properties to RDCSCC, and Use Restrictions on Undeveloped and Developed Areas	Soil Alternative S6—Excavation of Developed Area with ≥ 620 mg/kg Mercury, Excavation of Undeveloped Area and Other Properties to RDCSCC, and Use Restrictions on Developed Area	Soil Alternative S7—Excavation of Undeveloped, Developed, and Other Properties to RDCSCC and Use Restrictions on the Railroad
(d) Time until RAOs are achieved	▪ The RAOs to prevent potential migration of contamination, through airborne emissions and/or runoff, would not be achieved using this alternative.	▪ The RAOs to prevent migration of COCs in soil through surface water runoff or airborne emissions would be met following cap construction. ▪ The RAO to prevent potential leaching of mercury, arsenic, and lead to groundwater at concentrations that result in exceedance of the PRGs would be met following cap construction.	▪ Excavation would immediately eliminate areas with soil exceeding 620 mg/kg of mercury in the undeveloped fill area. ▪ The RAOs to prevent migration of COCs in soil through surface water runoff or airborne emissions would be met following cap construction. ▪ The RAO to prevent potential leaching of mercury and arsenic to groundwater at concentrations that result in exceedance of the PRGs would be met following cap construction, which is assumed to immediately follow excavation.	▪ Excavation would immediately eliminate areas with soil exceeding 620 mg/kg of mercury at the Site. ▪ The RAOs to prevent migration of COCs in soil through surface water runoff or airborne emissions would be met following cap construction. ▪ The RAO to prevent potential leaching of mercury and arsenic to groundwater at concentrations that result in exceedance of the PRGs would be met following cap construction, which is assumed to immediately follow excavation.	▪ Excavation would immediately eliminate areas with soil exceeding 620 mg/kg of mercury at the Site. ▪ The RAOs to prevent migration of COCs in soil through surface water runoff or airborne emissions would be met following cap construction. ▪ The RAO to prevent potential leaching of mercury and arsenic to groundwater at concentrations that result in exceedance of the PRGs would be met following cap construction, which is assumed to immediately follow excavation.	▪ Excavation would immediately eliminate mercury in soil in the undeveloped fill area. ▪ The RAOs to prevent migration of COCs in soil through surface water runoff or airborne emissions would be met following cap construction in the developed area. ▪ The RAO to prevent potential leaching of mercury and arsenic to groundwater at concentrations that result in exceedance of the PRGs would be met following cap upgrades in the developed area.	▪ Excavation would immediately eliminate mercury in all soils. ▪ The RAO for future use as an industrial property would only be achieved after demolition of existing facilities, excavation, and reconstruction of new facilities.
6.Implementability							
(a) Technical feasibility	▪ No impediments.	▪ No impediments. ▪ Cap would also allow for storm water re-routing, which currently is an issue at the Site, specifically in the developed area.	▪ The main technical challenge for the excavation is the management of mercury-impacted soil, including excavation, treatment, and disposal. ▪ Cap would also allow for storm water re-routing, which currently is an issue at the Site, specifically in the developed area.	▪ The main technical challenge for the excavation is the management of mercury impacted soils, including excavation, treatment, and disposal. ▪ Cap would also allow for storm water re-routing, which currently is an issue at the Site, specifically in the developed area.	▪ The main technical challenge for the excavation is the management of mercury impacted soils, including excavation, treatment, and disposal. ▪ Cap would also allow for storm water re-routing, which currently is an issue at the Site, specifically in the developed area.	▪ Technical challenge to ensure proper monitoring and capture of any fugitive vapors during excavation. ▪ Technical challenge for the excavation in the undeveloped fill area is the management of mercury impacted soils, including staging and loading for the large volume of soil to be generated. ▪ Technical challenge with extensive stormwater/erosion controls during excavation of undeveloped fill area.	▪ Technical challenge to ensure proper monitoring and capture of any fugitive vapors during excavation. ▪ Technical challenge for excavation is the management of mercury impacted soils, including excavation, treatment, and disposal. ▪ Technical challenge with extensive stormwater/erosion controls during excavation. ▪ Technical challenge for demolition of existing industrial facilities to allow for excavation.
(b) Administrative feasibility	▪ No impediments.	▪ Administratively feasible. Property owners (except Lin-Mor) and potential developers concurred to restrict usage of each parcel.	▪ Administratively feasible. Property owners (except Lin-Mor) and potential developers concurred to restrict usage of each parcel.	▪ Administratively feasible. Property owners (except Lin-Mor) and potential developers concurred to restrict usage of each parcel.	▪ No impediments.	▪ Disposal facilities may not be able to treat/dispose of large volume of soil in timely manner.	▪ Disposal facilities may not be able to treat/dispose of large volume of soil in timely manner. ▪ Workers in buildings that have impacts (specifically the developed area buildings) would be impacted since this alternative would cause the facilities to be shutdown and the buildings demolished.
(c) Availability of services and materials	▪ None needed.	▪ Services and materials are available.	▪ Services and materials are available.	▪ Services and materials are available.	▪ Services and materials are available.	▪ Services and materials are available.	▪ Services and materials are available.
7. Total Cost							
Direct Capital Cost	▪ $0	▪ $5,610,000	▪ $7,930,000	▪ $13,550,000	▪ $14,140,000	▪ $112,580,000	▪ $135,300,000
Annual O&M Cost	▪ $0	▪ $29,900	▪ $29,900	▪ $31,000	▪ $30,600	▪ $5,500	▪ $0
Total Present Worth Cost	▪ $36,000	▪ $6,130,000	▪ $8,450,000	▪ $14,090,000	▪ $14,670,000	▪ $112,750,000	▪ $135,300,000

TABLE 5-2
Comparison of Soil Media Alternatives – By Property

ACTIONS	SOIL ALTERNATIVES S1	S2	S3	S4	S5	S6	S7
Capital Cost, $	0	5,610,000	7,930,000	13,550,000	14,140,000	112,580,000	135,300,000
Present Value Cost, $	36,000	6,130,000	8,450,000	14,090,000	14,670,000	112,750,000	135,300,000
No Further Action	x						
Use Restriction(1)							
Blum		x	x	x			
Prince		x	x	x			
Lin-Mor							
Wolf		x	x	x	x	x	
US Life		x	x	x	x	x	
EJB		x	x	x			
Borough of Wood-Ridge		x	x	x			
Norfolk Southern		x	x	x	x	x	x
Undeveloped Area		x	x	x	x		
Excavate Soil >620 mg/Kg							
Undeveloped Area			x	x	x	x	x
Wolf				x	x	x	x
US Life				x	x	x	x
Excavate Soil to RDCSCC							
Blum					x	x	x
Prince					x	x	x
Lin-Mor		x	x	x	x	x	x
Wolf							x
US Life							x
EJB					x	x	x
Borough of Wood-Ridge					x	x	x
Norfolk Southern							
Undeveloped Area						x	x
55' Buffer and Line West Ditch(2)		x	x	x	x	x	x
Indoor Air Monitoring(2)		x	x	x	x	x	

(1) Use restriction actions include either existing cap upgrades, or new cap as required
(2) Added to NJDEP Alternative List

TABLE 5-3
Detailed Evaluation of Groundwater Media Alternatives

Alternative Description: Criterion	Groundwater Alternative G1—No Further Action	Groundwater Alternative G2—Natural Attenuation and Institutional Controls	Groundwater Alternative G3—Hydraulic Controls via Pumping	Groundwater Alternative G4—Groundwater Pump and Treat	Groundwater Alternative G5—Vertical Hydraulic Barrier	Groundwater Alternative G6—Vertical Hydraulic Barrier Around Site Perimeter
1. Overall Protection of Human Health and the Environment.	▪ Mercury, arsenic, and benzene would continue to persist in groundwater at concentrations exceeding the PRGs. ▪ Continues to allow the potential for fluxing of COCs into Berry's Creek. ▪ There is a potential for human exposure to contaminated groundwater since no institutional controls are part of this alternative. However, groundwater is not currently used for potable purposes in the area.	▪ The potential for human exposure to contaminated groundwater would be eliminated through institutional controls. Under this alternative, the institutional controls would be required to be in effect for the foreseeable future. ▪ In conjunction with any active soil remedial alternative, the environment would be protected by eliminating the potential for groundwater migration to Berry's Creek. ▪ Calculations of mass flux of mercury and arsenic in Berry's Creek would be reduced by an order of magnitude through the installation of a cap.	▪ This alternative collects impacted groundwater along the downgradient portion of the plume to ensure no continued migration of contaminants exceeding PRGs. ▪ This alternative is not protective of the environment since the remedial action may cause injury to natural resources (wetlands and Berry's Creek). ▪ The potential for human exposure to contaminated groundwater would also be minimized through institutional controls. Under this alternative, the institutional controls would be required to be in effect for the foreseeable future, although possibly for less time than for Groundwater Alternatives G1 and G2.	▪ This alternative actively reduces the concentrations of mercury, arsenic, and benzene in groundwater over all of the plume, thus reducing the timeframe to meet the PRGs. ▪ This alternative is not protective of the environment since the remedial action is likely to cause injury to natural resources (wetlands and Berry's Creek). ▪ The potential for human exposure to contaminated groundwater would be minimized through institutional controls while operation the pump and treat system. Under this alternative, the institutional controls would be required to be in effect for decades (assumed 25 years), though less time than the other alternatives.	▪ This alternative encapsulates impacted groundwater through the installation of a vertical hydraulic barrier system surrounding the Wolf Warehouse. ▪ The potential for human exposure to contaminated groundwater would be minimized through institutional controls. Under this alternative, the institutional controls would be required to be in effect for the foreseeable future, similar in length to Groundwater Alternative G2. ▪ Berry's Creek would be protected by controlling groundwater flow in the area where mercury, arsenic, and benzene exceed PRGs.	▪ This alternative encapsulates impacted groundwater through the installation of a vertical hydraulic barrier system surrounding the developed and undeveloped areas. ▪ The potential for human exposure to contaminated groundwater would be minimized through institutional controls. Under this alternative, the institutional controls would be required to be in effect for the foreseeable future, similar in length to Groundwater Alternative G2. ▪ Berry's Creek would be protected by controlling groundwater flow in the area where mercury, arsenic, and benzene exceed PRGs.
2. Compliance with ARARs	▪ Would meet ARARs when mercury, arsenic, and benzene contamination in groundwater do not result in concentrations that exceed groundwater PRGs. Under this alternative, this would most likely persist indefinitely.	▪ Would meet ARARs when mercury, arsenic, and benzene contamination in groundwater do not result in concentrations that exceed groundwater PRGs. Under this alternative, this would potentially take decades.	▪ Would likely not meet location-specific ARAR for the protection of wetlands (NEPA, 40 CFR 6, Appendix A).	▪ Would likely not meet location-specific ARAR for the protection of wetlands (NEPA, 40 CFR 6, Appendix A).	▪ Would meet ARARs when mercury, arsenic, and benzene contamination in groundwater does not result in concentrations that exceed groundwater PRGs. Since this area would be encapsulated indefinitely and no dilution and/or dispersion would occur, this would take decades.	▪ Would meet ARARs when mercury, arsenic, and benzene contamination in groundwater does not result in concentrations that exceed groundwater PRGs. Since this area would be encapsulated indefinitely and no dilution and/or dispersion would occur, this would take decades.
3. Long-Term Effectiveness and Permanence						
(a) Magnitude of residual risks	▪ No significant change in risk because no action taken. Reduction in risk relating to mercury, arsenic, and benzene contamination in groundwater would remain indefinitely.	▪ No significant change in risk because no action taken. Natural attenuation (dilution and dispersion) would cause mercury and arsenic concentrations to decrease over time.	▪ Since this option does not rely on active groundwater pumping within the developed area, residual risks would remain for a longer period of time, but would meet the PRGs sooner than alternatives G1 or G2.	▪ Residual risks would be eliminated once the groundwater collection system remediates groundwater over the entire plume. This is anticipated to take approximately 25 years. However, the actual time of remediation would be influenced by a number of site-specific factors and may differ significantly from this estimate.	▪ No significant change in risk because no action taken to reduce mercury, arsenic, and benzene concentrations in groundwater. Reduction in risk relating to mercury, arsenic, and benzene contamination in groundwater would remain for decades by encapsulating area exceeding PRGs.	▪ No significant change in risk because hydraulic controls to limit mounding of groundwater within containment footprint minimally reduces mercury, arsenic, and benzene concentrations in groundwater. Reduction in risk relating to mercury, arsenic, and benzene contamination in groundwater would remain for decades by encapsulating area exceeding PRGs.
(b) Adequacy and reliability of controls	▪ Not applicable.	▪ Requires reliance on institutional controls for groundwater. These controls would be necessary for decades under this alternative. These controls are reliable since the Site is in an industrial area and potable water is available.	▪ Requires reliance on institutional controls for groundwater. These controls would be necessary for decades under this alternative. These controls are reliable since the site is in an industrial area and potable water is available.	▪ Requires reliance on institutional controls for groundwater during remediation. These controls are reliable since the site is in an industrial area and potable water is available.	▪ Requires reliance on institutional controls for groundwater. These controls would be necessary for decades under this alternative. These controls are reliable since the site is in an industrial area and potable water is available.	▪ Requires reliance on institutional controls for groundwater. These controls would be necessary for decades under this alternative. These controls are reliable since the site is in an industrial area and potable water is available.

TABLE 5-3
Detailed Evaluation of Groundwater Media Alternatives

Alternative Description: Criterion	Groundwater Alternative G1—No Further Action	Groundwater Alternative G2—Natural Attenuation and Institutional Controls	Groundwater Alternative G3—Hydraulic Controls via Pumping	Groundwater Alternative G4—Groundwater Pump and Treat	Groundwater Alternative G5—Vertical Hydraulic Barrier	Groundwater Alternative G6—Vertical Hydraulic Barrier Around Site Perimeter
4. Reduction of Toxicity, Mobility, or Volume through Treatment						
(a) Treatment process used	▪ Not applicable.	▪ Natural attenuation (primarily dilution and dispersion) only.	▪ Groundwater collection along the downgradient portion of the plume for discharge to the POTW. ▪ No treatment is anticipated on generated groundwater prior to discharge to the POTW due to the low concentrations believed to be in influent groundwater. GAC treatment has been included for safety factor, but is not assumed to be needed for treatment.	▪ Would extract groundwater throughout the plume. ▪ Mercury removal through ion exchange ▪ Solids, iron, arsenic, and manganese removal completed by greensand filtration (with applicable backwashing)	▪ No treatment process used in this alternative. Only control of groundwater flow considered part of this alternative.	▪ Groundwater collection within the footprint of the hydraulic barrier to maintain hydraulic control and subsequent discharge to the POTW. ▪ No treatment is anticipated on generated groundwater prior to discharge to the POTW due to the low concentrations believed to be in influent groundwater. GAC treatment has been included for safety factor, but is not assumed to be needed for treatment.
(b) Degree and quantity of TMV reduction through Treatment	▪ Not applicable.	▪ Natural attenuation would take decades.	▪ Would eventually remove the entire groundwater area exceeding PRGs, but would take decades to complete. Ex situ treatment of groundwater utilizing GAC would be implemented prior to discharge.	▪ Would remove nearly all the mercury, arsenic, and benzene mass in groundwater during operational time of system.	▪ Not applicable. No treatment completed.	▪ Not applicable. Very limited treatment completed.
(c) Irreversibility of TMV reduction	▪ Not applicable.	▪ Dilution and dispersion are the main natural attenuation processes in this alternative. After attenuation occurs, the process is irreversible.	▪ Irreversible because impacted groundwater is removed and discharged to the POTW.	▪ Groundwater treatment is irreversible. Residuals of ion exchange are disposed of offsite.	▪ Not applicable since no treatment occurring.	▪ Not applicable since very limited treatment occurring.
(d) Type and quantity of treatment residuals	▪ None, because no treatment included.	▪ None, since the dilution and dispersion processes will reduce mercury, arsenic, and benzene concentrations to below groundwater PRGs.	▪ None generated onsite because no treatment is necessary prior to discharge to POTW. ▪ Mercury treated at POTW may generate residuals(such as digester waste) with residual mercury contamination.	▪ Residual contamination for disposal remains after ion exchange treatment.	▪ None, because no treatment included.	▪ None, because very limited treatment included.
(e) Statutory preference for treatment as a principal element	▪ Preference not met for groundwater because no treatment included.	▪ Preference not met for groundwater because no treatment beyond natural attenuation included.	▪ Preference met for groundwater because GAC treatment is included.	▪ Preference met for groundwater because ion exchange treatment is included.	▪ Preference not met for groundwater because no treatment included.	▪ Preference not met for groundwater because very limited treatment included.
5. Short-Term Effectiveness						
(a) Protection of workers during remedial action	▪ No remedial construction, so no risks to workers.	▪ No remedial construction, so no risks to workers.	▪ Minimal risks to workers during construction or operation of the pumping system. Proper health and safety requires must be followed during construction and operation.	▪ Minimal risks to workers during construction or operation of the pumping system. Proper health and safety requires must be followed during construction and operation.	▪ Risks to workers during installation due to elevated mercury in soils that would need to be managed during vertical hydraulic barrier installation.	▪ Risks to workers during installation due to elevated mercury in soils that would need to be managed during installation of vertical hydraulic barrier.
(b) Protection of community during remedial action	▪ No remedial construction, so no short-term risks to community.	▪ No remedial construction, so no short-term risks to community.	▪ Slight risks to the community during construction and operation of the system. For noise, equipment would be housed within a building and would be designed to reduce noise levels.	▪ Slight risks to the community during construction and operation of the system. For noise, equipment would be housed within a building and would be designed to reduce noise levels.	▪ Slight risks to the community during the construction of the slurry wall. Increased truck traffic (deliveries of slurry materials, sheeting) would impact local community. ▪ Air monitoring would be necessary during the installation of the slurry wall component to ensure no fugitive dust emissions occur.	▪ Slight risks to the community during the construction of the vertical hydraulic barrier. Increased truck traffic (deliveries of slurry materials and/or sheeting) would impact local community. ▪ Air monitoring would be necessary during the installation of the slurry wall component to ensure no fugitive dust emissions occur.

TABLE 5-3
Detailed Evaluation of Groundwater Media Alternatives

Alternative Description: Criterion	Groundwater Alternative G1—No Further Action	Groundwater Alternative G2—Natural Attenuation and Institutional Controls	Groundwater Alternative G3—Hydraulic Controls via Pumping	Groundwater Alternative G4—Groundwater Pump and Treat	Groundwater Alternative G5—Vertical Hydraulic Barrier	Groundwater Alternative G6—Vertical Hydraulic Barrier Around Site Perimeter
(c) Environmental impacts of remedial action	▪ No remedial construction, so no environmental impacts.	▪ No remedial construction, so no environmental impacts.	▪ Significant risks to environment probable by pumping along Berry's Creek and Diamond Shamrock/Henkel (north) Ditch. Would have impacts to water levels in Berry's Creek and wetlands. ▪ Pumping would most likely cause natural resource injury to adjacent wetlands and surface water bodies.	▪ Significant risks to environment probable by pumping along Berry's Creek and Diamond Shamrock/Henkel (north) Ditch. Would have impacts to water level in Berry's Creek and wetlands. ▪ Pumping would most likely cause natural resource injury to adjacent wetlands and surface water bodies.	▪ May have risks to the environment due to the flow changes in groundwater surrounding the vertical hydraulic barrier. Adequate flow controls diverting water around the vertical hydraulic barrier may be necessary.	▪ May have risks to the environment due to the flow changes in groundwater surrounding the vertical hydraulic barrier. Adequate flow controls diverting water around the vertical hydraulic barrier may be necessary. ▪ Would have impacts to water levels in Berry's Creek and wetlands.
(d) Time until RAOs are achieved	▪ Long-term attainment of groundwater RAOs would persist indefinitely under this alternative. ▪ Other remaining RAOs are not met.	▪ Long-term attainment of groundwater RAOs would take decades to meet under this alternative.	▪ The pumping system would operate for approximately 50 years to reduce concentrations of mercury, arsenic, and benzene to below PRGs. ▪ PRGs may be difficult to attain since the system relies on natural migration of mercury to the downgradient collection wells. Data demonstrates that mercury and arsenic is not mobile in groundwater.	▪ It is estimated that the pumping system would operate for approximately 25 years to reduce mercury, arsenic and benzene concentrations to below PRGs. The actual time required to achieve PRGs may be influenced by a number of site-specific factors and could significantly differ from the estimated 25 years.	▪ Long periods of time would likely be required to meet PRGs since this alternative only includes controlling groundwater flow, not treatment.	▪ Long periods of time would likely be required to meet PRGs since this alternative only includes controlling groundwater flow, with very limited groundwater treatment.
6. Implementability						
(a) Technical feasibility	▪ No impediments.	▪ No impediments	▪ If pilot testing results demonstrate higher concentrations of mercury than anticipated, this process may not be technically feasible since GAC treatment effectiveness is limited for mercury.	▪ Significant unknown on treatment levels for mercury using ion exchange at low concentrations. Published data document verified treatment at higher concentrations to near 5-10 ug/L for mercury, but are unknown at concentrations below those levels.	▪ May be technically difficult to control water flowing over the area where vertical hydraulic barrier is installed. ▪ May cause flooding of undeveloped fill area if groundwater flowing into the area is not diverted. ▪ May be difficult to install slurry wall adjacent to existing buildings and other structures (railroads, roadways, etc.).	▪ May be technically difficult to control water flowing over the area where vertical hydraulic barrier is installed. ▪ May cause flooding of undeveloped fill area if groundwater flowing into the area is not diverted. ▪ May be difficult to install slurry wall adjacent to existing buildings and other structures (railroads, roadways, etc.).
(b) Administrative feasibility	▪ No impediments.	▪ No impediments.	▪ The substantive requirements for discharge to the POTW would be met, but no impediments are expected.	▪ The substantive requirements for discharge to the POTW would be met, but no impediments are expected.	▪ No impediments.	▪ No impediments.
(c) Availability of services and materials	▪ None needed.	▪ None needed.	▪ Necessary engineering services and materials readily available for installation and operation of system.	▪ Necessary engineering services and materials readily available for installation and operation of system.	▪ Necessary engineering services and materials readily available for installation of system.	▪ Necessary engineering services and materials readily available for installation of system.
7. Total Cost	Total Capital Cost $0 Annual O&M Cost $0 Total Present Worth Cost $36,000	Total Capital Cost $25,000 Annual O&M Cost $24,000 Total Present Worth Cost $520,000	Total Capital Cost $1,020,000 Annual O&M Cost $180,000 Total Present Worth Cost $3,670,000	Total Capital Cost $2,300,000 Annual O&M Cost $740,000 Total Present Worth Cost $10,950,000	Total Capital Cost $1,360,000 Annual O&M Cost $24,000 Total Present Worth Cost $1,860,000	Total Capital Cost $4,230,000 Annual O&M Cost $166,000 Total Present Worth Cost $6,690,000

TABLE 5-4
Comparison of Groundwater Media Alternatives – By Property

ACTIONS	ALTERNATIVES 1	2	3	4	5	6
Capital Cost, $	0	25,000	1,020,000	2,300,000	1,360,000	4,230,000
Present Value Cost, $	36,000	520,000	3,670,000	10,950,000	1,860,000	6,690,000
No Action	x					
Groundwater Use Restrictions[(1)]		x	x	x	x	x
Groundwater Monitoring						
MW-1, 4, 6, 7, 10, & 13		x	x	x	x	x
Natural Attenuation		x				
Groundwater Extraction at the Edge of Berry's Creek and the Diamond Shamrock/Henkel Ditch			x			
Groundwater Pumping From Within the Plume to Remediate Groundwater				x		
Groundwater Pumping From Within the Plume to Control Groundwater Mounding						x
Groundwater Treatment (Sand Filtration and GAC)			x			x
Groundwater Treatment (Sand Filtration, GAC and Ion Exchange)				x		
Vertical Hydraulic Barrier around High Mercury Concentration Groundwater (Wolf Warehouse)					x	
Vertical Hydraulic Barrier around Site Perimeter						x
Discharge to POTW			x	x		x

1. Use restrictions to be placed on the area of groundwater exceeding PRGs.